Change Number	Federal Facility Agreement and Consent Order Change Control Form	Date
M-45-10-2	Do not use blue ink. Type or print using black ink.	6/28/10

Originator | **Phone**

U.S. DOE-ORP

Class of Change

[ ] I – Signatories [ ] II – Executive Manager [X] III - Project Manager

Change Title

RFI/CMS Work Plan Primary Document Schedule Modification.

Description/Justification of Change

Updates of the schedule and text of the *Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C* (RPP-PLAN-39114, Rev. 1; Work Plan) and *Sampling and Analysis Plan for Phase 2 Characterization of Vadose Zone Soil in Waste Management Area C* (RPP-PLAN-38777, Rev. 1; SAP) are required to respond to Washington State Department of Ecology (Ecology) concerns that the schedule provided in the Work Plan is not being achieved [J.J. Lyon, Ecology, to S.J. Olinger, U.S. Department of Energy, Office of River Protection (ORP), "*Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*, RPP-PLAN-39114, Revision 1, (Work Plan)," Letter dated March 29, 2010]. During a meeting to discuss the Ecology concerns, Ecology and ORP agreed that revisions to the Work Plan would be prepared to address the schedule changes as well as the technical challenges that are impacting the schedule. Text in the SAP is also being revised to maintain consistency with the Work Plan. This Change Control Form documents the necessary text and schedule updates. The schedule modifications that are reflected in the revisions to the Work Plan and SAP do not impact Hanford Federal Facility Agreement and Consent Order (HFFACO) proposed Interim Milestone M-45-61 to submit a Phase 2 RCRA Facility Investigation/Corrective Measures Study Report for Waste Management Area C by 12/31/2014.

(See Page 2 for continuation of Description/Justification of Change.)

Impact of Change

This change revises and updates the Work Plan and SAP to reflect the current schedule and technical activities for Waste Management Area C, in response to concerns expressed by Ecology.

Affected Documents

- *Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*, RPP-PLAN-39114, Revision 1
- *Sampling and Analysis Plan for Phase 2 Characterization of Vadose Zone Soil in Waste Management Area C*, RPP-PLAN-38777, Revision 1
- Hanford Site internal planning, management, and budget documents (e.g., Baseline Control documents, and related work authorizations and directives).

Approvals

	Date	
DOE: R.W. Lober, Project Manager for Vadose Zone	7/26/2010	✓ Approved ______ Disapproved
EPA	Date	______ Approved ______ Disapproved
Ecology: J.J Lyon, TPA Project Manager	9-21-10	✓ Approved ______ Disapproved

Description/Justification of Change (cont.)

The updates to the Work Plan affect the Executive Summary and Sections 1, 4, 6, and 8 of the document. The revised pages of the Work Plan are provided as Attachment 1. The SAP is revised in its entirety and is provided in whole as Attachment 2. Underline is used for text additions; ~~strike-out is used for text deletions~~.

M-45-10-2

Attachment 1

Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C,
RPP-PLAN-39114,
Revision 1A (Changed Pages)

EXECUTIVE SUMMARY

This work plan describes the field work necessary to collect the data identified in RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C Corrective Measures Study*, and supports the Phase 2 *Resource Conservation and Recovery Act of* 1976 (RCRA) facility investigation/corrective measures study (RFI/CMS) work plan and sampling and analysis plan activities for the single-shell tank (SST) Waste Management Area (WMA) C (Figure 1-1). As discussed in the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) Action Plan (Ecology et al. 1989), the Phase 2 RFI/CMS work plan is prepared to present information on how the Phase 2 RFI/CMS processes will be conducted and eventually lead to proposed remedies for WMA C fulfilling HFFACO Milestone M-45-60 (Ecology and DOE 2007, *Federal Facility Agreement and Consent Order Change Control Form Change No. M-45-06-03, Modifications of Tank Farm Corrective Measures and Interim Measures Milestone*). This work plan also integrates with RPP-PLAN-37243, *Phase 2 RCRA Facility Investigation/Corrective Measures Study Master Work Plan for Single-Shell Tank Waste Management Areas* (Phase 2 Master Work Plan), as described in HFFACO Milestone M-45-58 and Appendix I, section 2.3 (Ecology and DOE 2007). This WMA C~~e~~ RFI/CMS uses the framework established in the Phase 2 Master Work Plan~~RPP-PLAN-37243, *Single-Shell Tank Phase 2 Resource Conservation and Recovery Act of 1976 Facility Investigation/ Corrective Measures Study Master Work Plan*~~, which is the implementation plan for integrating the RCRA treatment, storage, and disposal (TSD) unit closure process with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) groundwater and soil operable unit remedial investigation/feasibility study (RI/FS) process~~ including the groundwater program~~. The integration of these two ~~regulations~~ processes will be implemented through management project teams as defined in DOE/RL-2007-20, *Hanford Integrated Groundwater and Vadose Zone Management Plan*. Groundwater has been impacted by some waste releases in WMA C. However, evaluations of groundwater contamination and remediation are not in the scope of this Phase 2 work plan. Investigating groundwater contamination under WMA C is part of the 200-BP-5 groundwater operable unit RI/FS conducted by DOE-RL.

For this work plan, site characterization will be performed at the 23 sites listed in Table ES-1 and shown on Figure ES-1. These characterization activities include the following:

a. Soil collection and analysis through direct push technology.
b. Tissue sampling for ecological risk assessment.
c. Drywell and groundwater monitoring well geophysical logging.
d. Surface geophysical exploration (SGE).

Table ES-1 includes the sampling method, implementation design, and objective. Not shown in Table ES-1 or in Figure ES-1 is the development of a geophysical logging tool that can detect beta emitters, which is also included in this work plan.

Soil samples for chemical analysis will be collected using direct push technology at 18 of the 23 selected sites. The number of sampling direct pushes ranges from one to three at each site for a total of up to 29 direct pushes. Furthermore, a demonstration of SGE with deep electrodes is also planned at site N. Following the demonstration, if SGE is successful at site N, a plan would

Table ES-1. Sample Plan WMA C Phase 2 Characterization for RFI/CMS (3 sheets)

Map Design.	Group[a]	Location	Deployment	Number of ~~Holes~~Direct Pushes	Average Number of Samples[c]	Known or Suspected Event	Objective	Access Availability	Ecology/ Stakeholder Interest
A	G3	Spare inlet 241-C-101	Direct push, slant	1-2	8	Tank over fill. Loss through spare inlet	Characterize C-101 release and refine conceptual models 1, 2, and 4	Fair	High
B	G2	241-C-101, south side	Direct push, vertical or slant	1	8	Tank release	Characterize C-101 release and refine conceptual models 1 and 2	Good	High
C	G4	241-C-203	Direct push, slant	3	3: 0-15 ft 15: >15 ft	Tank leak and/or tank over fill. Loss through spare inlet	Determine if C-200 actually leaked and refine conceptual models 1, 2, and 4	Fair	Moderate to high
D	G4	241-C-201 241-C-202 241-C-204	Direct push, slant	1-2/tank	8	200 series tank leaks	Determine if C-200 actually leaked and refine conceptual models 1, 2, and 4	Fair	Moderate, depending on C-203 results
E	G2	Between 241-C-106 and 200-C-109	Direct push, vertical	1	8	Suspected release	Assess ^{60}Co and refine conceptual models 1, 2, and 4	Fair	High
F	G2	Bldg C-801 chemical drain	Direct push, vertical	1	8	Suspected release site	Assess release of PUREX waste, ^{137}Cs and ^{99}Tc, and ^{60}Co and refine conceptual models 1, 2, and 4	Good	Moderate to high
G	G2	Between Bldg C-801 and 241-C-103	Direct push, vertical	1	8	Suspected transfer line release site	Assess release and ^{60}Co and refine conceptual models 1, 2, and 4	Good	High
H	G5	Northeast side of E-91	Direct push, vertical	1	8	Surface release	Surface exposures and assess ^{60}Co and surface release conceptual Model	Good	High
I	G5	Northeast side of E-115	Direct push, vertical or slant	1	8	Surface release	Surface exposures and assess ^{60}Co and surface release conceptual model, refine conceptual models 1, 2, and 4	Good	High
J	G3	241-C-104	Direct push, slant	1	8	Tank release	Assess suspected release and refine conceptual models 1, 2, and 4	Fair	High
K	G2	241-C-108	Direct push, vertical or slant	1	8	Transfer line leak, hot dry well (09-02)	Assess suspected release and refine conceptual models 1, 2, and 4	Poor	High

Table ES-1. Sample Plan WMA C Phase 2 Characterization for RFI/CMS (3 sheets)

Map Design.	Group[a]	Location	Deployment	Number of ~~Holes~~Direct Pushes	Average Number of Samples[c]	Known or Suspected Event	Objective	Access Availability	Ecology/ Stakeholder Interest
L	G2	241-C-103 and 241-C-106	Drywell logging and direct push, vertical	2 ~~/ log drywells~~	8	Potential transfer line leak and tank over fill	Update logging data for ^{60}Co, ^{137}Cs, uranium, and moisture and assess potential release and refine conceptual models 1, 2, and 4	Fair	Moderate
M	G7	241-C-104, 108, 109, 110, 111, and 112	Drywell logging	N/A	N/A		Update logging data for ^{60}Co, ^{137}Cs, uranium, and moisture	Fair to good	Moderate
N	G8	UPR-86, UPR-82 and UPR-81	SGE	N/A	N/A		Test SGE, define plume at unplanned releases (UPR)-82 and -86; refine conceptual models 1, 2, and 4	Good	High
O	G9	WMA C	SGE	N/A	N/A		3-D vision of suspected releases – may lead to supplemental sample locations	Good	High
P	G1	UPR-81	Balance of direct pushes to complete characterization	3	8	Known release site	Characterize release and refine conceptual models 1, 2, and 4	Good	High
Q	G6	UPR-82	(1) 4 adjacent direct pushes to support placement of strings of deep electrodes for 3D SGE per Map Design. N; (2) Direct push through center depending on SGE results[b] ~~of UPR-82~~	1	8	Known release site	~~Penetrate center of mass, and~~ Test SGE: resolve depth with deep electrodes; define plume at UPR-82; refine conceptual models 1, 2, and 4	~~Good~~Poor due to shotcrete cover	High
R	G2	241-C-301 Catch Tank	Direct push vertical	1	8	Unlined concrete catch tank	Assess potential catch tank release and refine conceptual models 1, 2, and 4	Good	Moderate to high

Table ES-1. Sample Plan WMA C Phase 2 Characterization for RFI/CMS (3 sheets)

Map Design.	Group[a]	Location	Deployment	Number of ~~Holes~~Direct Pushes	Average Number of Samples[c]	Known or Suspected Event	Objective	Access Availability	Ecology/ Stakeholder Interest
S	G5	UPR-72 and C-8 Drain	Direct push vertical	1	8	Buried radioactive material and French drain from 241 CR Building are in this area	Assess presence of buried material and potential releases to C-8 drain and refine conceptual models 1, 2, and 4	Good	Moderate to high
T	TBD	TBD, based on SGE data for entire WMA	TBD, direct push vertical and/or slant	TBD	TBD	Previously unknown release sites	TBD	TBD	Moderate to high
U	G3	C-110	Direct push, slant or vertical	1	8	Tank leak and/or tank over fill. Loss through spare inlet	Characterize C-110 release and conceptual models 1, 2, and 4	Fair	High
V	G2	C-111	Direct push vertical	1	8	Tank leak and/or tank overfill. Loss through spare inlet	Characterize C-111 release and ~~con-ceptual~~ conceptual models 1, 2, and 4	Good	High
W	G9	~~299-E27-4,~~ 299-E27-12, 299-E27-13, 299-E27-14, 299-E27-15	Log groundwater monitoring wells outside of WMA C	N/A	N/A		Log wells to collect data on U, ^{60}Co, ^{137}Cs, and moisture	Good	High

[a] Group refers to the expected work package associated with the characterization effort broadly defined as follows:

G1 = Direct push at UPR-81 (covered by existing work package).

G2 = Vertical direct pushes at nine investigative sites around the 100-series SSTs.

G3 = Slant direct pushes at three investigative sites around the 100-series SSTs.

G4 = Slant direct push at the C-200 Series tanks.

G5 = Outside the WMA, vertical direct push at the investigative sites.

G6 = Vertical direct push through gunite at UPR-82.

G7 = Drywell logging at select dry wells.

G8 = Three separate SGE areas at the following locations: UPR-81, UPR-82, and UPR-86.

G9 = Deploy SGE at WMA C taking into account the results from testing at site N.

[b] Sampling design details for Map Design. Q are applicable to the single direct push that may be undertaken for sampling. Additional probe holes will be placed to support logging/electrode placement.

[c] Value includes one surface sample.

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1. INTRODUCTION

This work plan describes the field work necessary to collect the data identified in RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C Corrective Measures Study*, and supports the Phase 2 *Resource Conservation and Recovery Act of 1976* (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) work plan and sampling and analysis plan activities for the single-shell tank (SST) Waste Management Area (WMA) C (Figure 1-1). The content and structure of this work plan follow the RCRA RFI/CMS work plan format established in OSWER Directive 9902.3-2A, *RCRA Corrective Action Plan – Final*, with modifications to concurrently satisfy the additional *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) requirements in accordance with Appendix I of the *Hanford Federal Facility Agreement and Consent Order* (HFFACO).

As discussed in the HFFACO Action Plan (Ecology et al. 1989), the Phase 2 RFI/CMS work plan is prepared to collect characterization data under the Phase 2 RFI/CMS process that eventually leads to proposed remedies for WMA C. This document fulfills the requirements of HFFACO Milestone M-045-60 (Ecology and DOE 2007). This work plan also integrates with RPP-PLAN-37243, *Phase 2 RCRA Facility Investigation/Corrective Measures Study Master Work Plan for Single-Shell Tank Waste Management Areas* (~~the~~ Phase 2 ~~m~~Master ~~w~~Work ~~p~~Plan) as described in HFFACO Milestone M-045-58 and Appendix I, section 2.3 (Ecology and DOE 2007). The RFI/CMS process uses the framework established in the Phase 2 Master Work Plan~~RPP-PLAN-37243, *Single-Shell Tank Phase 2 Resource Conservation and Recovery Act of 1976 Facility Investigation/ Corrective Measures Study Master Work Plan*~~, which is the implementation plan for integrating the RCRA treatment, storage, and disposal (TSD) unit closure process with the CERCLA groundwater and operable unit remedial investigation/feasibility study (RI/FS) process including the groundwater program. The integration between the vadose zone program and the groundwater program is described in Chapter 5 of the Phase 2 Master Work Plan ~~(RPP-PLAN-37243)~~.

The U.S. Department of Energy (DOE), and State of Washington Department of Ecology (Ecology) recently concluded negotiations on HFFACO milestone changes for completing the Phase 1 RFI/CMS process with HFFACO Milestone M-45-55. These negotiations also included the development of a clear vision for the planning and execution of Phase 2 final RCRA RFI/CMS process which also takes into account integration with other site groundwater and vadose zone cleanup efforts on the Hanford Central Plateau (Ecology and DOE 2007, *Federal Facility Agreement and Consent Order Change Control Form Change No. M-45-06-03, Modifications of Tank Farm Corrective Measures and Interim Measures Milestones*). The modification (M-45-55, M-045-58 and M-045-60) and additional milestones (M-045-61 and M-45-62) will establish a framework for completion of corrective measures within WMA C (M-45-60 through M-045-62) and a Phase 2 Tank Farm Corrective Action Master Work Plan (M-45-58 and amended HFFACO Appendix I, Section 2.3) to define the overall corrective action completion approach and sequence for other tank farms or WMAs (Ecology and DOE 2007). Modifications to the M-45 series of HFFACO (Ecology et al. 1989) milestones for *Tank Farm Corrective Measures and Interim Measures* approved in December 2007 (Ecology and DOE 2007) contains modifications to M-45-55, M-45-58, and M-45-60, and added milestones M-45-61 and M-45-62. The modifications combined M-45-55-T04 with M-45-55 and M-45-55, Section 2.3, was modified to describe the contents of RPP-PLAN-372~~7~~43, which ~~that~~ provides the conceptual process and sequencing approach for all SST farms and selection criteria for implementing Phase 2 RCRA corrective action.

Where information regarding treatment, management, and disposal of radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the *Atomic Energy Act of 1954*) is incorporated into this document, it is not incorporated for the purpose of regulating the radiation hazards of such components under the authority of the Revised Code of Washington (RCW) 70.105, "Hazardous Waste Management Act," and its implementing regulations, but is provided for information purposes only.

1.1 PURPOSE, SCOPE, AND OBJECTIVES

This work plan presents background information, existing contaminant distribution data, and the approach that will be used for characterization and corrective action decision-making for WMA C. The potentially applicable technologies and the need for treatability studies are discussed in Chapter 5.

This work plan addresses only WMA C and its surrounding vicinity as defined in RPP-RPT-38152. Waste Management Area C, which is a RCRA WMA, includes the C Farm that consists of the following:

a. Twelve 100-series SSTs, each with 535,000-gal capacity.
b. Four 200-series SSTs, each with 55,000-gal capacity.
c. Waste transfer lines.
d. Multiple drywells around each 100-series SST used as leak detection systems.
e. Tank ancillary equipment, including diversion boxes, catch tanks, and related structures.
f. Associated unplanned releases (UPR) to the soil.

This work plan contains SAPs for the Phase 2 corrective action process (Appendixes A and B). The soil SAP includes a quality assurance project plan and the sampling specifications for the characterization activities in the field (Appendix A). Previous characterization efforts (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*) and historical information (RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases*) associated with WMA C ~~was~~ were used in the development of this work plan. Data-gathering activities included compiling and reviewing existing process-knowledge information. WMA C site characterization data also have been gathered and evaluated. This existing information and the new characterization data that will be acquired as part of this Phase 2 sampling approach for this work plan will be used in the Phase 2 RFI/CMS report for WMA C presently due to Ecology on December 31, 2010 (Ecology and DOE 2007). However, the length of time to collect the characterization data extends beyond the approved HFFACO Milestone M-45-61 date for the submittal of the CMS report. ~~and~~ A revised CMS report submittal date is included as a part of recently concluded negotiations between DOE and Ecology [Ecology and DOE 2009, *Hanford Federal Facility Agreement and Consent Order Change Control Form Change No. M-45-09-01, Milestone Modifications to the M-045-00 series for Single-Shell Tank Retrieval and Closure of Single-Shell Tanks, resulting from the 2007-2009 Hanford negotiations on changes to the*

Hanford Federal Facility Agreement and Consent Order (HFFACO, also known as the Tri-Party Agreement)].~~may need to be renegotiated.~~

The results from sampling and other characterization activities will be used to update the contaminant distribution models as needed and to support the CMS decision-making process. This work plan focuses on identifying and gathering the characterization information that will be needed for evaluating the selection of the preferred remedy(ies) from the CMS alternatives. Results of the characterization activities will be used for evaluating risk to potential receptors and for the CMS alternative analyses.

To focus the activities needed for future remedy selection for WMA C, this Phase 2 RFI/CMS work plan has incorporated the following.

a. Information-gathering activities are continuing, including location and characterization of releases, throughout the RFI/CMS process. As characterization results become available, they will be compared with information concerning operational history and construction details. This approach will allow for any subsequent data collection needs to be adapted as needed. Data gathering requirements are tailored to accommodate the characteristics of the entire WMA C and integration with the groundwater program, tank closure, and adjacent operable units, as appropriate.

b. Potential corrective measures alternatives (CMA) are identified and described. Potential remedies associated with WMA C initially are identified in the work plan. Corrective measures alternatives analysis will be completed in the Phase 2 RFI/CMS report for WMA C (HFFACO Milestone M-45-61) using data collected from both Phase 1 and 2 field characterization and risk evaluation activities.

Following approval of this work plan, the major elements (RFI/CMS steps) are requirements that are not expected to change; therefore, the work plan should not change. Specific work scope elements might require modification or refinement as the work progresses. Changes that do not affect the overall intent of the approved work plan or schedule can be made in the field and documented in the daily log books that are maintained in the field as stated in Section 12.4 of the HFFACO Action Plan (Ecology et al. 1989). Alternatively, and if agreed to by the U.S. Department of Energy, Office of River Protection (ORP) and the lead regulatory agency, unit managers' meetings or predecessor primary documents requiring ORP and lead regulatory agency approval also can be used to document changes. Changes to the project schedule that affect assigned HFFACO M-045 interim milestones will require approval through the HFFACO (Ecology et al. 1989) change control process.

Supporting characterization data acquired during the field investigation that will be used for corrective measures decision-making for WMA C will be presented in the Phase 2 RFI/CMS report.

1.2 DATA QUALITY OBJECTIVES PROCESS FOR WMA C

EPA/240/B-06/001, *Guidance on Systematic Planning Using Data Quality Objectives Process*, was used to identify the data needs described in this work plan. The primary participants in this process were the Tank Operations Contractor (TOC), Ecology, and ORP. However, to ensure integration with other activities within the 200 East Area (RPP-PLAN-37243, Chapter 5), U.S. Environmental Protection Agency (EPA); U.S. Department of Energy, Richland Operations Office (RL); and Plateau Remediation Contractor also participated in the process but did not attend every workshop. This DQO process established the assumptions and global issues associated with Phase 2 characterization activities at WMA C. The Tribal Nations and Oregon stakeholders were provided informational meetings and sent the data quality objectives (DQO) and Revision 0 of this document for their review. The Phase 2 WMA C DQO summary report (RPP-RPT-38152) summarizes the outcome of the DQO process for WMA C during the Phase 2 RFI/CMS process.

1.3 DOCUMENT STRUCTURE

This Phase 2 RFI/CMS work plan is organized to present information as follows:

- **Chapter 1** – *Introduction*
- **Chapter 2** – *Background and Setting*
- **Chapter 3** – *Waste Management Area C Site Characterization Efforts*
- **Chapter 4** – *Work Plan Rationale and Approach*
- **Chapter 5** – *RCRA Facility Investigation/Corrective Measures Study Process*
- **Chapter 6** – *Schedule*
- **Chapter 7** – *Project Management and Program Integration*
- **Chapter 8** – *References*

Appendix A contains the SAP for the Phase 2 characterization activities for soils planned for the vadose zone in WMA C, while Appendix B contains the sampling and analysis instructions for collecting tissue samples from small mammals. The sampling and analysis tasks presented in this sampling and analysis instructions guide are specific to small mammal collection and analysis to obtain data for use in dietary exposure modeling in the ecological risk assessment for WMA C. Attachments 1 through 4 support Appendices A and B with the quality assurance program description (Attachment 1), general health and safety plan (Attachment 2), information management overview (Attachment 3), and waste management plan (Attachment 4).

1.4 QUALITY ASSURANCE

The DOE document DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)~~TOC document, TFC-PLN-02, *Quality Assurance Program Description* (QAPD), is provided in Attachment 1 of this work plan. It~~ establishes the quality requirements for environmental data collection, including sampling and analysis, in support of the SST *Resource Conservation and Recovery Act of 1976* (RCRA) Corrective Action Program (RCAP). The HASQARD~~This QAPD~~ applies specifically to field and laboratory activities associated with evaluating subsurface contaminant impacts involving 200 Areas SST WMA~~s~~ releases to the environment. ~~The QAPD complies with the requirements of DOE O 414.1C, *Quality Assurance*; Title 10, *Code of Federal Regulations*, Part 830.120, "Quality Assurance Requirements" (10 CFR 830.120), "Quality Assurance Requirements";~~ The

HASQARD complies with the requirements of EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*~~; DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD); and ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*, as applied~~. The HASQARD~~QAPD~~ also identifies technical procedural requirements that will describe field data collection and sampling and analysis requirements to be implemented during the investigation. Technical procedures will be identified in the SAP to address the requirements of the HASQARD (DOE/RL-96-68). The HASQARD ~~purpose of Attachment 1 is to~~ provides a framework of the general requirements that apply to RCAP characterization and remedial efforts.

The TOC quality assurance document, TFC-PLN-02, *Quality Assurance Program Description* (QAPD), establishes quality assurance requirements not covered in specific field and laboratory activities. This document is provided in Attachment 1 of this work plan. The QAPD incorporates the requirements of ASME NQA-1, *2004 Quality Assurance Requirements for Nuclear Facility Applications (QA)*, as required by the TOC contract with ORP.

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4. WORK PLAN RATIONALE AND APPROACH

The Phase 2 RCRA corrective action process is the RCRA-specified method by which UPRs to the environment are characterized and corrective action alternatives are evaluated and implemented if required to minimize potential risks to human health and the environment. Furthermore, this RCRA-specified method is consistent with the CERCLA method for characterization and remediation. HFFACO (Section 7.1) lists and compares the major steps involved with cleanup of RCRA and CERCLA "past practices" and concludes they are functionally equivalent (see also Section 3.1.2 of RPP-PLAN-37243). Objectives and data needs must be identified before designing a data collection program to support the Phase 2 RFI/CMS process. The data collected are used as a basis for making an informed risk management decision regarding the most appropriate corrective action(s) to implement. The data needs for field characterization efforts at WMA C were identified through a DQO process (RPP-RPT-38152) that was executed based on the requirements established in the HFFACO commitments (Ecology and DOE 2007). The data identified in the DQO process will be collected in accordance with HFFACO Milestone M-45-60 (i.e., this work plan), HFFACO Milestone M-45-00, and HFFACO Appendix I.

4.1 RATIONALE

Further understanding of subsurface conditions and contaminant migration processes is required to support decision-making on interim measures and corrective measures (Section 3.2.3). A comprehensive list of data needed to support these decisions was developed based on the current level of understanding in a DQO process (RPP-RPT-38152). However, it is generally recognized on both a technical and regulatory basis that present knowledge of existing contaminant concentrations, contaminant inventory, distribution of contaminants in the vadose zone from past releases, and uncertainties associated with contaminant migration processes is insufficient to support future decision-making for corrective actions. Therefore, there is a need to collect additional information through Phase 2 field and laboratory investigations, which will be supplemented by ongoing groundwater and vadose zone monitoring data, to support decisions on corrective actions and WMA closure. Groundwater monitoring data are collected on a regular basis as part of the RCRA groundwater monitoring program, while vadose monitoring ~~-~~(HRR leak detection monitoring and leak detection mitigation and monitoring) takes place during waste retrieval operations.

Characterization objectives and data needs for WMA C were developed during the DQO process (RPP-RPT-38152) carried out under the Phase 2 ~~RFI/CMS~~ M~~m~~aster W~~w~~ork P~~p~~lan (RPP-PLAN-37243) and this work plan. The development of this document and characterization activities for Phase 2 were supported by the DQO process.

The DQO process (EPA QA/G-4, *Guidance on Systematic Planning Using the Data Quality Objectives Process*) is a planning approach, based on the scientific method,[15] for defining the decisions that any data collected should satisfy. The EPA seven-step DQO process and several

[15] The scientific method involves the principles and processes regarded as characteristic of or needed for scientific investigation, including rules for concept formation, conduct of observations and experiments, and validation of hypotheses by observations or experiments.

4.4.1 Site Selection using Alternative 1: Phase 1 Conceptual Model

The Phase 1 conceptual model was used to select a number of sites to investigate. These sites consist of known or potential release sites that may have impacted the soils (Figure 4-2). To support tanks that may have been overfilled and potentially lost waste out the spare inlet ports, sites A (C-101) and J (C-104) were chosen.

Sites B, C, D, R, U, and V were chosen to support possible tank leaks and/or overfill events that lack existing drywell monitoring coverage. This includes southeast side of C-101 (Site B), the C-200-series tanks (Sites C and D), and C-801 (Site R). Sites B, C, D, U, and V are also being investigated to evaluate alternative conceptual model 2. For Sites U and V associated with tanks C-110 and C-111 respectively, it should be recognized that a low probability of hitting the contamination exists, based on the historic gamma logging and spectral gamma logging as reported in in Section 5 of GJO-98-39-TARA. The report states, "There appears to be little contamination around tanks C-110 and C-111, both of which are assumed leakers." It goes on to say, "Historical logs near tank C-111 showed no evidence of a past leak from this tank." It does suggest that the contaminants may have migrated downward and did not extend laterally to reach the surrounding monitoring boreholes (i.e., drywells). Therefore, the probability of hitting contamination under tank C-111 is quite low. The basis for placing tank C-111 as a "leaker" is a level decrease of 8.5 inches from 1965 through 1969 that would equal a total of 23,400 gal. In 1989, the leak loss value assigned was a 5.5 kgal leak. New temperature data can document the tank evaporation over this time period to account for this decrease as noted in *Tank 241-C-111 Leak Assessment Report*, RPP-ASMT-39155, dated October 2008. If a slant probehole beginning at the west-southwest corner of the tank is not feasible, then this slant probehole should not be installed because of the low probability of hitting any contaminants. This point of entry would align with the point of release associated with an overfill at the spare inlet ports and would be following the direction of the assumed release under the tank (i.e., down stratigraphic dip and lateral spreading from the point of release), exactly the same strategy and alignment used on the SX-108 slant borehole (see RPP-7884 for the rationale of placement). This strategy would support alternative conceptual model 2 of the work plan.

Although UPR-200-E-82 (Site Q) was investigated during Phase 1, it will be further investigated as part of this work plan. At UPR-200-E-82, the highest concentration of ^{99}Tc and nitrate was found at 80 ft bgs (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*). This limiting depth (80 ft bgs) was a result of the characterization limitations of the direct push technology deployed at that time using a slant probehole to collect the sample. This slant probehole at the time of deployment eliminated the possibility of going deeper in light of the gunite cap on top of this UPR. ~~Therefore, the proposed~~~~Ideally a~~A vertical push through the gunnite cap had been proposed but not implemented~~center of mass will would allow for characterization deeper in the soil column to quantify the ability to find out how deep the ^{99}Tc and nitrate has migrated, thus defining the depth of ^{99}Tc and nitrate at this location., h However,~~ due to radiological control requirements~~, a push through the center of the mass this cannot be accomplished~~. Instead, four direct push holes will be placed to a depth of approximately 200 ft, one on each side of the UPR, and multi-depth electrodes will be placed. A three-dimensional SGE survey will be conducted to map the extent of any electrical anomaly resulting from this release. Since the time of the leak in December 1969 to sometime after 1991, UPR-82 was covered in sand and gravel. Sometime after 1991, the gunite cap was placed over it. This alternative effluent return route from the building C-801 tank C-103. Since one already existed, this installation could imply a problem existed in the old line, including a leaking pipeline.

The other method is SGE, in which the resistivity of the underlying strata is measured, thereby providing an indirect indication of where pipelines, tanks, and other infrastructure may have leaked into the environment. ~~Since~~ Because waste fluids at tank farms contain nitrate that can reduce the electrical resistivity of the underlying strata, the resistivity measurements will be made at site N (UPR-81, UPR-82, and UPR-86) and compared against samples taken at these sites. Furthermore, samples collected at site P (UPR-81) will be used to compare analytical data against resistivity data. Using the results from the testing of SGE at site N, a plan would be developed to interrogate WMA C and surrounding environment using SGE. This is designated as Site O. Advances that are realized in the application of SGE will be considered in developing additional deployments of this characterization approach.

4.4.5 Site Selection for Surface Contamination

UPR-200-E-91 (Site H) was a large area of contaminated soil, located north and east of the C Farm. In 1981 contaminated soil was removed from this area and taken to another location (UPR-200-E-56). The radiological posting was removed in 1981. This release site is no longer marked or posted. This site was selected to verify the soils were removed. Waste site 200-E-115 (Site I) is selected as a site with surficial contamination that was discovered in October 2001.

4.4.6 Site Selection for Geophysical Logging

In addition to the list of sites that will be investigated, updated drywell spectral gamma monitoring of tanks C-103, C-104, C-106, C-108, C-109, C-110 C-111, and C-112 (Site M) will be conducted to investigate changes that may have occurred since 2000 as it relates to ^{60}Co migration. In addition to the drywells inside the WMA fenceline, the following groundwater wells would also be logged: 299-E27-12, 299-E27-13, 299-E27-14, and 299-E27-15 (Site W). These wells were selected because they are the only groundwater wells near WMA C that have not been logged, except 299-E27-14 that was last logged in the 1990s.

4.4.7 Groundwater Sampling Activities

Groundwater sampling activities at the WMA C RCRA wells are conducted under the Soil and Groundwater Remediation Project. Groundwater samples are collected and analyzed in accordance with DOE/RL-2009-77, *Interim Status Groundwater Quality Assessment Plan for the Single Shell Tank Waste Management Area – C*. This monitoring plan supersedes the previous groundwater monitoring plan (PNNL-13024, as revised) to incorporate changes that have occurred at WMA C. The most significant change at WMA C is the recent exceedance of the critical mean by the indicator parameter specific conductance. Furthermore, the dangerous constituent cyanide has been found in groundwater beneath the WMA C, and no upgradient source for cyanide has been identified. The first round of groundwater sampling under the new groundwater plan is scheduled to occur late in the 2009 calendar year. The analytes in the first round of sampling were developed from RPP-23403 and Appendix IX of 40 CFR 264. The results from these groundwater sampling activities will be available to the preparers of the RFI/CMS. No sampling of groundwater will be conducted as part of these characterization efforts. If any new RCRA groundwater monitoring wells are installed, the monitoring results from the new well would be used to further access the conceptual modes as they relate to groundwater flow.

4.5 SITE CHARACTERIZATION

For this work plan, site characterization will be performed at the 23 sites identified in Figure 4-2. The site characterization activities include the following:

a. Soil collection and analysis through direct push technology (Section 4.5.1).
b. Tissue sampling for ERA (Section 4.5.2).
c. Drywell and groundwater monitoring well geophysical logging (Section 4.5.3).
d. SGE (Section 4.5.4).

The characterization options selected for implementation at WMA C for this work plan are provided in Table 4-1. Table 4-1 includes the sampling method, implementation design, and objective. Not shown in Table 4-1 is the development of a geophysical logging tool that can detect beta emitters, which is also addressed in this work plan (Section 4.5.5).

Soil samples for chemical analysis will be collected using direct push technology at 18 of the 23 selected sites. The number of sampling direct pushes ranges from one to three at each site for a total of up to 29 direct pushes. Furthermore, a demonstration of SGE with deep electrodes is also planned at Site N. Site N includes the following unplanned release sites UPR-200-E-81, UPR-200-E-82, UPR-200-E-86. At each of these UPRs, high-resolution, three-dimensional SGE with deep electrodes is scheduled to be demonstrated. The first demonstration has already occurred at UPR-200-E-81 as part of revision 0 of this work plan. The demonstration ran from October 2008 to July 2009 at UPR-200-E-81 with the results documented in RPP-RPT-41236. Soil samples for contaminant analysis were also collected at this UPR and will be available later in the calendar year to compare results from the SGE against the chemical analysis. The UPR-200-E-82 is the next scheduled waste site for SGE to be deployed. ~~This is scheduled for the spring of 2010.~~ Following the demonstration, if SGE is successful at Site N for resolving depth of contaminants with deep electrodes, a plan would be developed to deploy SGE to encompass the WMA C DQO boundary. Additionally, new spectral gamma and moisture logging would be performed at tanks C-103, C-104, C-106, and C-108 through C-112. This work is contingent on available funding and on whether the direct push installation schedule is consistent with other schedule priorities. Additional characterization technology development (see Section 4.5.5) also is contingent on available funding.

The initial (Phase 1) site-specific investigation conducted between FY 2004 through FY 2007 entailed the installation of one vertical borehole near C-105 along with the application of direct push technology at UPR-82 (vertical and slant probeholes). To complement these data, direct pushes were conducted around UPR-86 and UPR-81 in FY 2008 (RPP-35169) that will provide additional information about contamination in the south portion of C Farm. The sampling plan consists of vertical and slant probeholes using direct push technology near selected waste releases along with SGEs around UPR-81, UPR-82, and UPR-86 and potentially WMA C. Spectral gamma and moisture logging around certain tanks with drywells that have detected ^{60}Co will be logged as will the groundwater monitoring wells that have not been spectral gamma logged in the past.

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Table 4-1. Sample Plan WMA C Phase 2 Characterization for RFI/CMS (3 sheets)

Map Design	Group[a]	Location	Deployment	Number of ~~Holes~~Direct Pushes	Average Number of Samples[c]	Known or Suspected Event	Objective	Accessibility	Ecology/ Stakeholder Interest
A	G3	Spare inlet 241-C-101	Direct push, slant	1-2	8	Tank overfill. Loss through spare inlet	Characterize C-101 release and refine conceptual models 1, 2, and 4	Fair	High
B	G2	241-C-101, south side	Direct push, vertical or slant	1	8	Tank release	Characterize C-101 release and refine conceptual models 1 and 2	Good	High
C	G4	241-C-203	Direct push, slant	3	3: 0-15 ft 15: >15 ft	Tank leak and/or tank overfill. Loss through spare inlet	Determine if C-200 actually leaked and refine conceptual models 1, 2, and 4	Fair	Moderate to high
D	G4	241-C-201 241-C-202 241-C-204	Direct push, slant	1-2/tank	8	200 series tank leaks	Determine if C-200 actually leaked and refine conceptual models 1, 2, and 4	Fair	Moderate, depending on C-203 results
E	G2	Between 241-C-106 and 200-C-109	Direct push, vertical	1	8	Suspected release	Assess ^{60}Co and refine conceptual models 1, 2, and 4	Fair	High
F	G2	Bldg C-801 chemical drain	Direct push, vertical	1	8	Suspected release site	Assess release of PUREX waste, ^{137}Cs and ^{99}Tc, and ^{60}Co and refine conceptual models 1, 2, and 4	Good	Moderate to high
G	G2	Between Bldg C-801 and 241-C-103	Direct push, vertical	1	8	Suspected transfer line release site	Assess release and ^{60}Co and refine conceptual models 1, 2, and 4	Good	High
H	G5	Northeast side of E-91	Direct push, vertical	1	8	Surface release	Surface exposures and assess ^{60}Co and surface release conceptual Model	Good	High
I	G5	Northeast side of E-115	Direct push, vertical or slant	1	8	Surface release	Surface exposures and assess ^{60}Co and surface release conceptual model, refine conceptual models 1, 2, and 4	Good	High
J	G3	241-C-104	Direct push, slant	1	8	Tank release	Assess suspected release and refine conceptual models 1, 2, and 4	Fair	High
K	G2	241-C-108	Direct push, vertical or slant	1	8	Transfer line leak, hot dry well (09-02)	Assess suspected release and refine conceptual models 1, 2, and 4	Poor	High

Table 4-1. Sample Plan WMA C Phase 2 Characterization for RFI/CMS (3 sheets)

Map Design	Group[a]	Location	Deployment	Number of ~~Holes~~Direct Pushes	Average Number of Samples[c]	Known or Suspected Event	Objective	Accessibility	Ecology/ Stakeholder Interest
L	G2	241-C-103 and 241-C-106	Drywell logging and direct push, vertical	2 ~~/ log drywells~~	8	Potential transfer line leak and tank overfill	Update logging data for ^{60}Co, ^{137}Cs, uranium, and moisture and assess potential release and refine conceptual models 1, 2, and 4	Fair	Moderate
M	G7	241-C-104, 108, 109, 110, 111, and 112	Drywell logging	N/A	N/A	N/A	Update logging data for ^{60}Co, ^{137}Cs, uranium, and moisture	Fair to good	Moderate
N	G8	UPR-86, UPR-82 and UPR-81	SGE	N/A	N/A	N/A	Test SGE: resolve depth with deep electrodes; define plume at UPRs-81, -82 and -86; refine conceptual models 1, 2, and 4	Good	High
O	G9	WMA C	SGE	N/A	N/A	N/A	3-D vision of suspected releases – may lead to supplemental sample locations	Good	High
P	G1	UPR-81	Balance of direct pushes to complete characterization for soil sampling	3	8	Known release site	Characterize release and refine conceptual models 1, 2, and 4	Good	High
Q	G6	UPR-82	(1) 4 adjacent direct pushes to support placement of strings of deep electrodes for 3D SGE per Map Design N; (2) Direct push through center, depending on SGE results[b] ~~of UPR-82~~	1	8	Known release site	Test SGE: resolve depth with deep electrodes; define plume at UPR-82; ~~Original plan called for Penetrate enetrating the center of mass, and to help~~ refine conceptual models 1, 2, and 4~~. Radiological control concerns have resulted in the current approach.~~	~~Good~~Poor due to shotcrete cover	High
R	G2	241-C-301 Catch Tank	Direct push vertical	1	8	Unlined concrete catch tank	Assess potential catch tank release and refine conceptual models 1, 2, and 4	Good	Moderate to high

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Table 4-1. Sample Plan WMA C Phase 2 Characterization for RFI/CMS (3 sheets)

Map Design	Group[a]	Location	Deployment	Number of ~~Holes~~Direct Pushes	Average Number of Samples[c]	Known or Suspected Event	Objective	Accessibility	Ecology/ Stakeholder Interest
S	G5	UPR-72 and C-8 Drain	Direct push vertical	1	8	Buried radioactive material and French drain from 241 CR Building are in this area	Assess presence of buried material and potential releases to C-8 drain and refine conceptual models 1, 2, and 4	Good	Moderate to high
T	TBD	TBD, based on SGE data for entire WMA	TBD, direct push vertical and/or slant	TBD	TBD	Previously unknown release sites	TBD	TBD	Moderate to high
U	G3	C-110	Direct push, slant or vertical	1	8	Tank leak and/or tank overfill. Loss through spare inlet	Characterize C-110 release and con-ceptual conceptual models 1, 2, and 4	Fair	High
V	G2	C-111	Direct push vertical	1	8	Tank leak and/or tank overfill. Loss through spare inlet	Characterize C-111 release and ~~con-ceptual~~ conceptual models 1, 2, and 4	Good	High
W	G9	~~299-E27-4,~~ 299-E27-12, 299-E27-13, 299-E27-14, 299-E27-15	Log groundwater monitoring wells outside of WMA C	N/A	N/A	N/A	Log wells to collect data on U, ^{60}Co, ^{137}Cs, and moisture	Good	High

[a] Group refers to the expected work package associated with the characterization effort broadly defined as follows:

G1 = Direct push at UPR-81 (covered by existing work package).
G2 = Vertical direct pushes at nine investigative sites around the 100-series SSTs.
G3 = Slant direct pushes at three investigative sites around the 100-series SSTs.
G4 = Slant direct push at the C-200 Series tanks.
G5 = Outside the WMA, vertical direct push at the investigative sites.
G6 = Vertical direct push through gunite at UPR-82.
G7 = Drywell logging at select dry wells.
G8 = Three separate SGE areas at the following locations: UPR-81, UPR-82, and UPR-86.
G9 = Deploy SGE at WMA C taking into account the results from testing at site N.

[b] Sampling design details for Sampling Site Designation Q are applicable to the single direct push that may be undertaken for sampling. Additional probe holes will be placed to support logging/electrode placement.

[c] Values include one surface sample.

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Table 4-1 shows the current understanding of access availability (i.e., October 2008) for each of the 23 sites. Specific sample locations will be selected based on defined site limitations (slope of the ground surface), and infrastructure constraints (see Figures 4-3 and 4-4). The actual sample locations will be established following the field survey with ground-penetrating radar (GPR) and other site preparation activities. This work plan calls for a sample to be taken at ground surface (i.e., 0 to 1 ft bgs). Although every attempt will be made to collect this sample, the gravel surface in tank farms may prevent taking a sample that contains environmentally sensitive media (i.e., soil particles less than 2 mm in diameter). If this is the case, pictures of the sampling site showing the gravelly nature of the land surface and the reason as to why a sample will not be taken will be documented in borehole/site completion reports.

The GPR and electrical surveys will define where subsurface conflicts exist, which will help define acceptable sample locations. During the survey, aboveground conflicts will also be defined.

The request to twin soil samples from new groundwater well boreholes with soil samples from direct push is a reasonable technical request that was provided by the Nez Perce in review of Revision 0 of this work plan. Although soil samples from direct pushes have been acquired, they are spatially separated by tens of feet from soil samples associated with boreholes. These soil samples can be compared and have shown similarities in pH and moisture content. However, with the potential changes in soil properties that might occur over those distances a meaningful comparison related to the differences in techniques is problematic. It would be more beneficial to have direct push soil samples that were located a few feet (~2 ft) apart from soil samples from the new groundwater monitoring well(s) borehole to allow a more valid comparison. The soil samples from the direct pushes and the proposed new groundwater well(s) can be compared and similarities in analytical values can be demonstrated. This twinning exercise will also support the technical merits of using moisture as an indicator for soil sampling targets. If we are successful in placing two new groundwater wells within 100 ft of the WMA C boundary, we propose placing twin direct push probe holes with those wells. If we cannot place the new wells, we will place the direct push probes holes to twin the geophysical logging of existing wells. Furthermore, this approach will also allow us to collect soil samples from new groundwater wells. The exact location will be dependent on waste retrieval activities associated with access to various locations. The preferred location as recommended by the Nez Perce and concurred with DOE-ORP and the contractor would be close to existing groundwater wells 299-E27-7 or 299-E27-14, which have shown groundwater impacts related to regional contamination as well as contamination associated with WMA C; however, the location may be modified due to existing site conditions and waste retrieval operations.

A planning process will be conducted to address collection of vadose zone data during installation of a planned RCRA groundwater monitoring well similar to the one conducted for 299-E27-22 (PNNL-13024).

For planning purposes, d~~D~~rill cutting samples will be collected in conjunction with the installation of a RCRA groundwater monitoring well that may be drilled near WMA C. From this well, near-continuous sediment samples from about 10 ft bgs to refusal will be collected. Drill cuttings and driven splitspoon samples will be collected from 10 ft bgs to near the total depth of the water table. Selected portions (21 samples) of the driven samples and cuttings will be analyzed for chemical and physical characteristics. From each stratigraphic unit, potential vertical locations for analyses will include stratigraphic contacts, weathered bedding structures, and lithologic facies changes. Splitspoon-driven soil samples will be taken every 10 ft starting at 50 ft bgs for a total of 21 samples. Inorganic chemicals, pH, moisture, and radionuclide suite of analyses will be performed on the samples~~ for planning purposes~~.

Deployment of direct-push technology at the proposed locations in WMA C would be expected to continue to address a number of questions related to the concentration and distribution of contaminants, including the following:

a. What contaminants are present that are routinely identified as contaminants of concern (COC) from a groundwater impact standpoint (e.g., ^{99}Tc, nitrate)?

b. What are the contaminant concentrations of ^{137}Cs and other COC in the upper 15 ft of the soils to provide soil data to support direct exposure and ecological risk assessment?

c. What is the vertical extent of the COC in the backfill material?

d. What is the horizontal extent of the COC across the areas of interest?

e. What are the potential drivers (e.g., sediment moisture profile) in the upper portion of the vadose zone that could control the migration of contaminants?

This option was selected because a probehole at these locations would provide source characterization data over the majority of WMA C along with distribution of contaminants at the locations of interest from WMA C. Source characterization would:

a. provide a basis for verifying estimating current location of COC inventories in the vadose zone

b. support evaluation of the spatial correlations between concentrations of COC and existing gamma data

c. support assessment of contaminant mobility, potential drivers (e.g., moisture content), and the effects of releases on soil properties to support predictive numerical modeling efforts necessary to evaluate potential future groundwater impacts, the associated risks, corrective measures, and further characterization as warranted.

Source characterization efforts also would involve identifying what contaminants are present and, subsequently, identifying the potential COCs for corrective action and closure decisions as they relate to soil and groundwater contamination.

4.5.1 Installation of Vertical/Slant Probeholes

Several options were considered for collection of vadose zone data. The preferred option is installation of direct push probehole(s). The direct push technology has been capable of obtaining a sample as deep as 240 ft bgs. It has the capability of obtaining more than one sample per probehole and does not bring up cuttings that need to be disposed. Furthermore, it does not take up as much space as a conventional drilling rig, which allows it to be deployed at more locations within the WMA C. The direct push technology provides the same objective as drilling a deep borehole given the data collection objectives. Up to 27 direct push probeholes are planned for 16 sampling locations. While the approximate locations for each probehole are shown on Figures 4-2 through 4-4, the exact locations for each probehole are dependent on the accessibility and subsurface interferences to the site, which will be determined after the results of a GPR survey become available. Vadose zone samples will be collected after the initial push is conducted and evaluated with soil moisture and gamma data. The precise sampling depths will be based on review of the geophysical logging data collected from the exploratory probehole. It is expected that the modified bismuth-~~germinate~~ germanium oxide logging tool (Section 4.6) will reduce the risk of selecting the wrong horizon to sample because of the lower detection limits associated with this tool.

For planning purposes, it is assumed that all direct push probeholes will be vertical, except for the probeholes at Sites A, C, D, J, and possibly Site U. At those sites, the probeholes would be slanted because the slope of the hill on the southwestern side of tanks C-101, C-104, C-110 (Sites A, J, and U) and the northeastern side of the C-200-series tanks (Figure 2-2, cross-sections A and B) prohibit placing the direct push rig close to the outlet ports at these tanks.

The goal of slanted direct push probeholes is to find evidence of tank fluids that have leaked into the vadose zone. Therefore, at these sites, the target region for samples is within 10 ft of the tank bottom. The exact angle, 30, 45, or 60 degrees, of the probehole to intersect the target region will be determined by field conditions (e.g., where can the direct push rig set up to avoid existing infrastructure). Figures 4-5 and 4-6 delineate possible angles for the slant holes at the 100-series tank and 200-series tanks, respectively. In these figures, the lines represent the probehole divided into 50-ft lengths with every 10-ft length marked. The slant boreholes at the C-200-series would also be extended to the southwest beyond the tanks to collect soil samples directly below pipelines running between the C-200-series and C-100-series tanks.

4.5.1.1 Direct Push Sampling Technique

The direct push technology uses a dual-wall percussion system to obtain multiple samples in a single probehole location. Driving will be conducted with outer push tubing that is currently planned to be 6.67 cm (2.625 in.) OD x 4.76 cm (1.875 in.) ID and inner tubing that is 3.17 cm (1.25 in.) OD x 2.7 cm (1.08 in.) ID. The dual-wall system with a "dummy" tip will be advanced to the predetermined sample depth. The tubing will be back-pulled 0.06 m (approximately 2 in.) to 0.12 m (approximately 5 in.) to relieve pressure and materials from the drive shoe and tip. When sampling depth is achieved and the rods back-pulled for sampling, the removable tip will be removed by extracting the inner rods. On removal of the inner string of tubing, a sampler will be attached to the inner string and returned to the bottom of the outer casing/push tubing and positioned against the inner receiver face of the drive shoe. The inner and outer tubing strings are "locked" together by use of a proprietary method, and the entire assembly is advanced through the targeted sample interval.

Additionally, Sites F and G should be investigated before Sites H and I. If contamination is not found at depth at Sites F and G, the depth of the direct push at Sites H and I will stop at 15 bgs. Sites H and I were located to address surficial contamination at UPR-200-E-91 and 200-E-115, but depths of the direct pushes can be extended if it appears contaminants are moving down dip northeasterly. If contamination is found at depth at Sites F and G, then the depth of the direct pushes at Sites H and I will be extended based on the information from Sites F and G. The purpose of extending the depth of these direct pushes is to provide information related to contaminant movement down dip (alternative conceptual model 2).

4.5.1.3 Ground-Scanning

Prior to implementing direct push sampling and SGE activities, ground scans are conducted to verify drawings that show areas containing buried equipment, underground structures, and pipelines. Ground scans typically use GPR, which uses a transducer to transmit frequency modulat~~e~~ed electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and, to some extent, electrical conductivity, reflect the transmitted energy. The GPR system measures the travel time between transmitted pulses and the arrival of reflected energy. The reflected energy provides the means for mapping subsurface features of interest. The display and interpretation of GPR data are similar to those used for seismic reflection data. When numerous adjacent profiles are collected, often in two orthogonal directions, a plan view map showing the location and depth of underground features can be generated.

4.5.1.4 Direct Push Sampling Strategy

For planning purposes, the following summarizes the sampling strategy (RPP-ENV-38838) at each vertical direct push site:

a. At each site, a minimum of two direct push probeholes pushes will be completed. The initial probehole is logged for both gross gamma using the modified bismuth-germinate oxide tool (Section 4.6) and neutron moisture. Following logging, single deep or multi-depth electrodes are installed for SGE. The second push is for soil sampling based on the data observed from the first push. An exception to this process will be applied at UPR-82, where four pushes will be made for the sole purpose of installing multi-depth electrodes in support of SGE at that location. Resulting resistivity data will be used to determine whether additional characterization action is appropriate at UPR-82.

b. The depth of the first push would be to no greater than 200 ft bgs or refusal at all sites except H, I, and S. This target depth is based on the observation of ^{99}Tc and nitrate at 160 ft bgs at borehole C4297 and ^{60}Co concentrations above 0.1 pCi/g between 150 and 160 ft bgs at well 299-E27-4. The depth at Site S would be to 260 ft bgs or refusal based on ^{60}Co above 0.1 pCi/g at nearby well 299-E27-14. At Sites H and I, the depth of the direct push would be 15 ft unless data from Sites F and G indicate that the direct pushes at Sites H and I should be deeper.

c. Deep electrodes are placed near the base of the initial probehole and at a depth of approximately 50 ft bgs. Multi-depth electrodes have an electrode every 20 ft from the bottom to a depth of approximately 40 ft bgs.

be analyzed for the chemicals and radionuclides listed in Tables 3-1 and 3-2, respectively, using the approach given in Section 3.5. This work plan calls for a sample to be taken at ground surface (i.e., 0 to 1 ft bgs). Although every attempt will be made to collect this sample, the gravel surface in tank farms may prevent taking a sample that contains environmentally sensitive media (i.e., soil particles less than 2 mm in diameter). If this is the case, pictures of the sampling site showing the gravelly nature of the land surface and the reason as to why a sample will not be taken will be documented in borehole/site completion reports.

4.5.2 Tissue Sampling

Presently, WMA C is managed in a way to eliminate, to the extent possible, the intrusion of plants and animals into the facilities. However, WMA C may have an impact on animals located outside WMA C. Therefore, in addition to the soil samples taken to evaluate ecological risk (Section 4.5.1.4), small mammal tissue sampling and analysis would be completed as a supplemental method for evaluating contaminant pathways and risks to wildlife receptors. Animals would be collected from around the perimeter of WMA C for tissue sampling. Appendix B provides the sampling and analysis instruction for collecting these samples.

4.5.3 Geophysical Logging

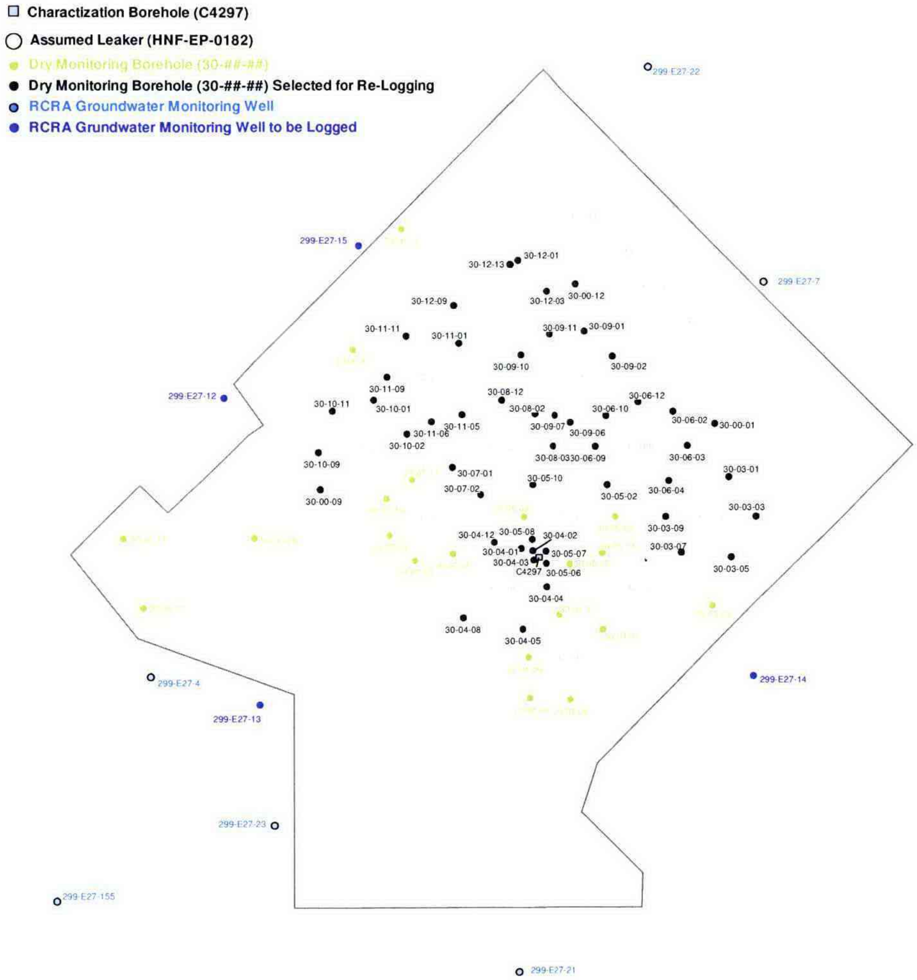
Based on concerns raised by stakeholders and Tribal Nations related to the presence and mobility of ^{60}Co, spectral gamma as well as moisture logging would be done for the drywells associated with tanks C-103 and C-106~~ with and in potential direct pushes to refine the ^{60}Co movement in this area~~. In addition, past releases from transfer lines in this vicinity may have impacted the soil as well as tank overfill events. The purpose of the spectral gamma logging would be to update the data collected during the baseline spectral gamma analysis conducted in 1998 (GJO-98-39-TAR) and 2000 (GJO-98-39-TARA). In addition, spectral gamma analysis in drywells around tanks C-104 and C-108 through C-112 would be performed to update the spectral gamma and moisture logging data to provide insight into changes that may have occurred since 2000. Figure 4-7 shows the locations of the drywells in WMA C.

Furthermore, three RCRA groundwater monitoring wells have not been logged with the spectral gamma tool (299-E27-12, 299-E27-13, and 299-E27-15). Therefore, geophysical logging would also be conducted at these wells as well as at 299-E27-14, which was last logged in the 1990s. All other groundwater monitoring wells were logged within the last 5 to 6 years and those wells will not be logged. The spectral gamma tool deployed should measure ^{137}Cs, ^{60}Co, ^{235}U, ^{238}U, and other gamma emitters in the soils as well as calculate a region of interest to provide a minimum detection limit for the tool. As part of the spectral gamma logging, KUT logs are also generated which are used to evaluate the location for tops of the stratigraphic layers.

4.5.4 Surface Geophysical Exploration

One of the characterization options considered and selected during the DQO process was SGE. This method of indirect investigation is proposed around UPR-200-E-81, UPR-200-E-82, and UPR-200-E-86. The SGE methodology and its results ~~could~~ would be interpreted with the insight of the direct push results from around these waste sites. In addition, electrodes at depth have been installed at these sites and would provide a first-of-its-kind opportunity to determine a three-dimensional version of SGE. If successful, the three-dimensional "vision" into the soils would aid in locating investigative direct pushes or boreholes to find waste with ionic strength, potentially ^{99}Tc and other mobile contaminants. Part of this work is to evaluate the relationship between electrical resistivity and waste fluid concentrations taken from probehole samples.

Figure 4-7. Drywell and RCRA Groundwater Monitoring Locations to be Logged



The task involves a three-dimensional resistivity survey surrounding UPRs -81, -82, and -86. Buried electrodes have been placed at each of these sites (UPR-82 = one, UPR-81 = six (four locations with two dual electrodes), and UPR-86 = four). Four additional arrays of vertical multi-depth electrodes are planned for placement adjacent to UPR-82. In addition, approximately 300 surface electrodes would be placed at each UPR. The preliminary plan is to treat each of these UPRs individually. The region is rich with underground piping. Each of the sites was reported as the location of significant loss of waste to the environment. Direct push investigation in each UPR region as part of the near-term work plan (RPP-PLAN-35341) would be used to verify the sites identified waste signatures commensurate with the leak loss estimate for the individual site and contrasted to the SGE results for each individual site. The results would be reported in the RFI/CMS report that fulfills HFFACO Milestone M-45-61.

~~A s~~Surveys that entail~~s~~ approximately 300 surface survey electrodes, arranged for a fully three-dimensional interrogation ~~is~~ are to be performed. Conceptually, this single string of electrodes would be placed so that each of the UPR locations is centered in the grid. Depth of interrogation is dependent on the size of the source and the resistivity contrast. The buried electrodes for each site would be included in the grid. At UPR-81, the preliminary results from the direct push at this location show the highest concentration of nitrate (199 mg/g) was found at 42 to 43 ft bgs. Therefore, the target depth for SGE at this location would be approximately 50 ft. The results from the deployment at the UPRs would be used to determine how SGE will be deployed over the entire WMA C. Using the results and lessons learned from the deployment of SGE at UPRs -81, -82, and -86, this work plan will be updated or a supplemental work plan will be generated to describe the field activities to support the deployment of SGE over the WMA C DQO boundary. In anticipation, single depth or strings of multi-depth electrodes will be placed at each direct push location during logging hole decommissioning.

During collection of the resistivity data, it will be necessary to deactivate cathodic protection and electrical leak detection systems in the region. Because of increased tripping hazards associated with the cables and perceived electrical hazards, access to the farm will be severely restricted during this activity.

4.5.5 Develop New Characterization Technology

At the present time, the only way to measure levels of ^{99}Tc contamination in the soil is to take samples to send to the laboratory for analysis. This methodology is labor intensive and provides samples only at chosen intervals (see Section 4.5.1.3). The development of a ^{99}Tc sensor that can be deployed during the placement or decommissioning of direct push probeholes could quickly indicate where sampling intervals should be located and avoid costs associated with null sample results. Such a sensor would be based on robust, existing technology of silicon beta detectors, noting that very few long-lived beta-emitting radionuclides exist in the Hanford sediments. The development of this sensor would be in two stages, a laboratory testing stage followed by deployment in the field. The prototype ^{99}Tc sensor would first be built and tested in the laboratory. If testing of the laboratory prototype proved successful, then a ^{99}Tc sensor that could log small-diameter probeholes would be built and field tested.

This work is contingent on available funding. If successful, d~~D~~evelopment of this ^{99}Tc sensor would provide cost-effective soil sampling related to the mobile contaminants of ^{99}Tc and nitrate that impact groundwater by only sampling in direct push probeholes that the ^{99}Tc sensor identified as having ^{99}Tc. The interest in this new technology was recognized through data needs workshops conducted for Phase 2 RFI/CMS processes and was shared with Ecology, who expressed an interest in deployment in WMA C. This new characterization technology, ^{99}Tc sensor, could~~will~~ aid in the selection of soil samples in addition to the standard use of gross gamma and neutron moisture logging data that is conducted before soil sampling decision-making (see Section 4.5.1.4). However, due to the developmental nature of this technology, it is not apparent that the ^{99}Tc sensor will be ready for field deployment in time to support site characterization activities at WMA C.

4.6 OPTIMIZING SAMPLING

Based on data needs identified in the DQO meetings, a number of options were considered for the Phase 2 characterization effort at WMA C. These characterization options included using direct-push technology and nonintrusive geophysical techniques (e.g., SGE) and updating spectral gamma logging around tanks C-103 and C-106 and C-104, C-108, C-109, C-110, C-111, and C-112 as well as groundwater monitoring wells 299-E27-12, 299-E27-13, 299-E27-14, and 299-E27-15. These options are based on characterization techniques and innovative technologies identified in RPP-PLAN-37243 and RPP-ENV-38838 for methods that have been successfully used on the Hanford Site. These options and potential deployment locations were evaluated in terms of the type of information that could be provided, as well as the technical risk associated with deployment during Phase 2. Although all of the options considered could provide valuable data that would serve to improve the understanding of subsurface contamination, a number of the options were considered to be of lesser value or not feasible due to technical risk for the characterization effort to be implemented beginning in FY 2009. The accessibility of some of these sites is limited by waste retrieval operation equipment located on the surface and subsurface infrastructure interferences for WMA C. The list of characterization options considered during the DQO process, along with the rationale for including or omitting each option from Phase 2 effort, is provided.

RPP-16608, *Site Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMAs A-AX, C, and U*, evaluated sampling and analysis options and alternative field sampling technologies. That evaluation and the experience gained during implementation of the Phase 1 RFI field investigation has resulted in identifying the following sampling technologies for the initial Phase 2 characterization efforts: direct push, SGE, and borehole logging. These technologies allow for investigations for the presence of contaminants in the vadose zone to be conducted using both indirect and direct evaluation techniques. Subsurface investigations will include geophysical logging using spectral gamma and moisture, SGE, and soil sampling using direct push technology.

Direct push technology is planned for use during the initial Phase 2 characterization of the vadose zone in WMA C. The advantage of this technology is ease in deployment, better option of evaluating lateral extent of contamination, no contaminated soil cutting being brought to the surface, and lower costs. The direct push technology plans to use the dual string approach where multiple samples can be collected. The dual string (2.625 in. OD) approach can collect a 1.08 in. x 24 in. sample at multiple depths. In the 200 East Area, the direct push technology has demonstrated the ability to go to great depths (~200 ft) thus providing the opportunity to use its advantages, especially no contaminated soil cuttings being brought to the surface. This is an advantage over traditional drilling of a borehole that is more expensive, provides no ability to easily evaluate lateral extent of contamination, and brings contaminated soil cuttings to the surface.

Figure 6-1. Project Logic and Schedule ~~(2 sheets)~~

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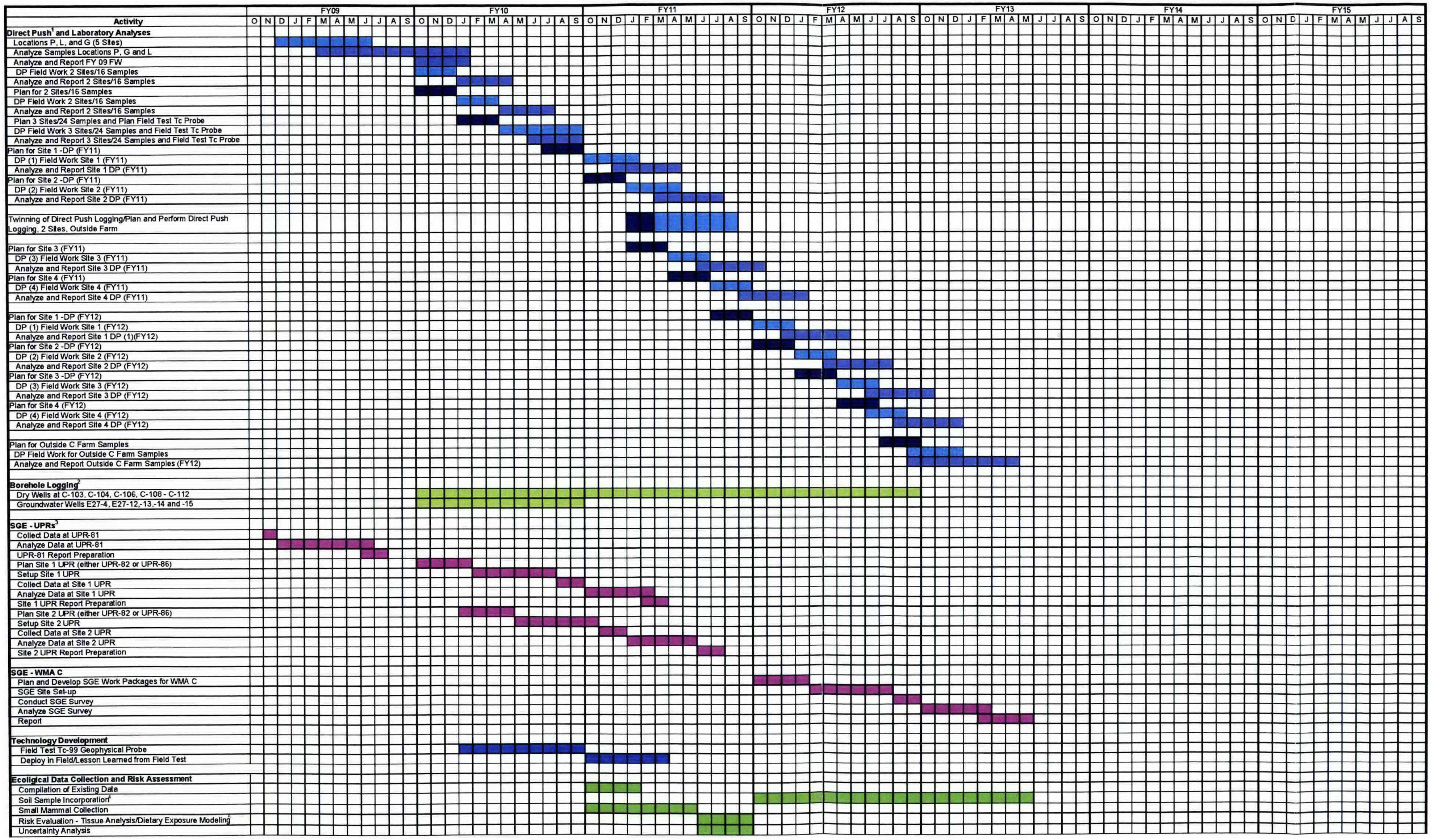

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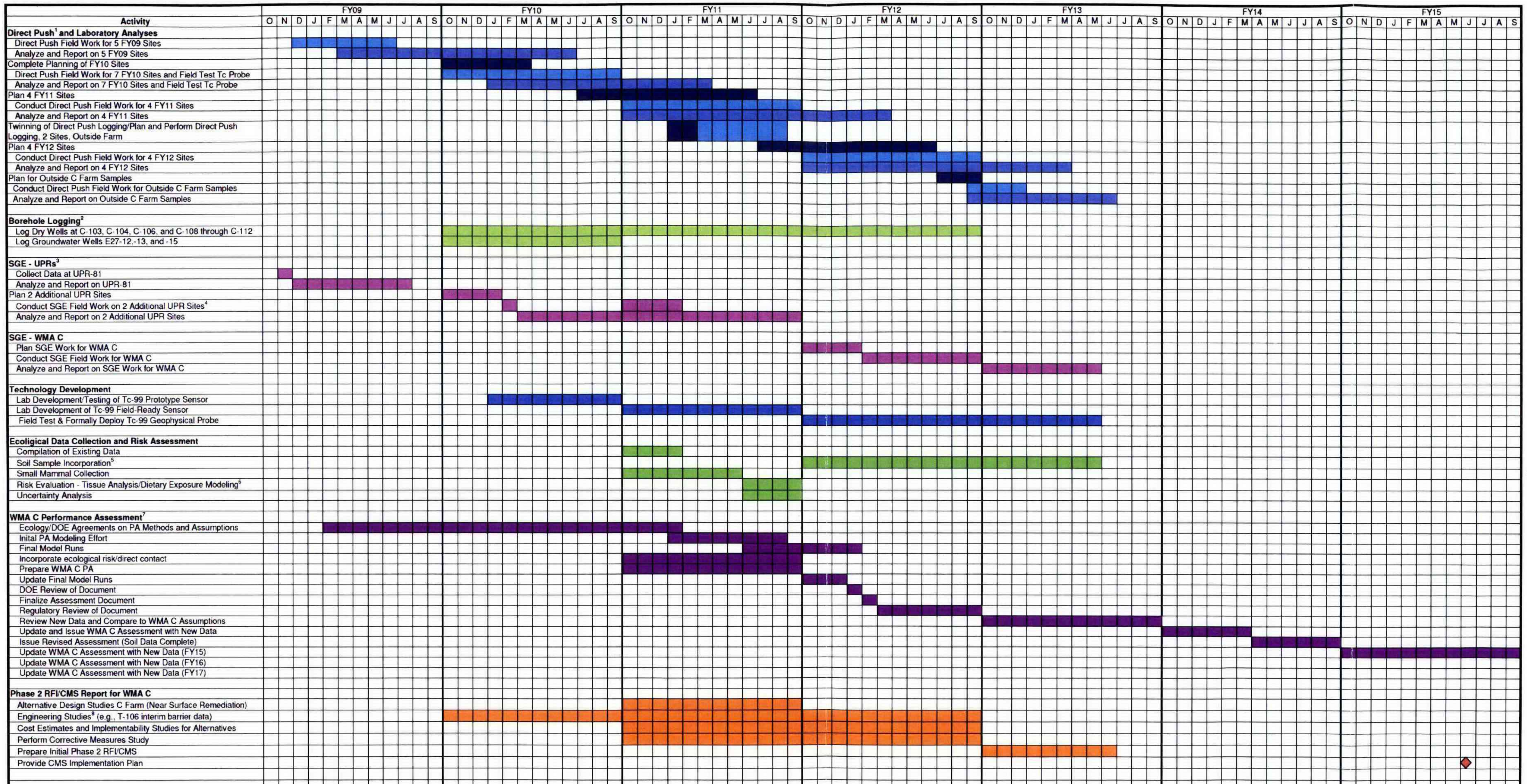
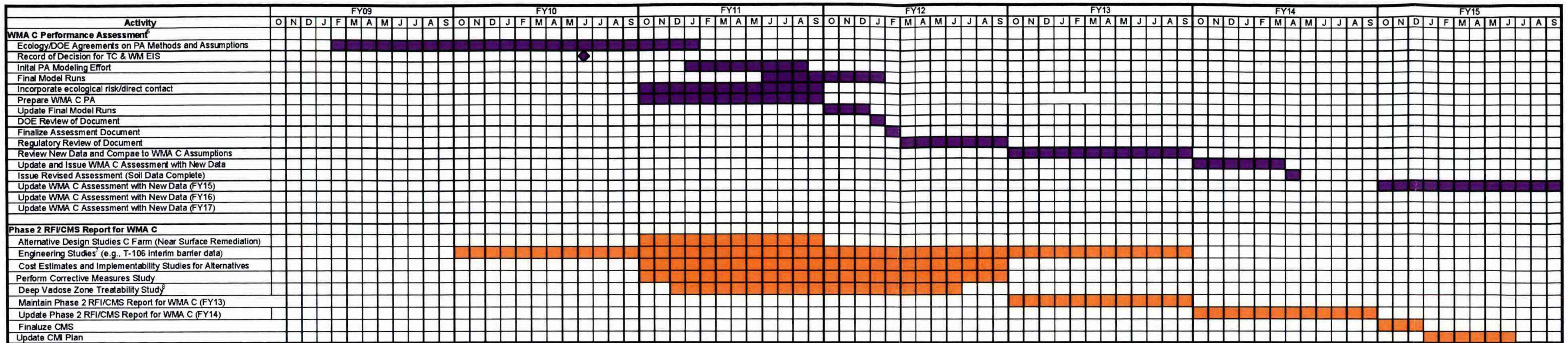


Tc = Technetium
PA = Performance Assessment
TC & WM EIS =

To fullfill this logic and duration schedule, durations assume $4 million/year for 3 years for WMA C soil characterization based on FY08 dollars.
Durations for activities assume no interferences from field activities, such as waste retrieval activities, which are currently ongoing.

[1] If sampling for organic compoiunds are not detected in first five probeholes, schedule is as shown, however, if found, scheluld is severly impacted and made longer.
[2] Will only take 3 months to do, there is uncertainty regarding contractor start date.
[3] SGE for UPRs began in October 2009.
[4] Second site begins following completion of 4 FY10 Direct Pushes adjacent to UPR-82.
[5] Begins when soil sample analyses are available and ends one month after last soil sampling analysis is complete.
[6] Can not begin until sufficient small mammal collection has occurred.
[7] Anticipated WMA C Performance Assessment schedule based on ongoing working sessions with Regulators, NRC, Tribal Nations, and other interested stakeholders, as well as on timing of issuance of the TC & WM EIS record of decision.
[8] Additional engineering studies may be needed, but will need the soil analyses to provide meaningful input to those studies.



To fulfill this logic and duration schedule, durations assume $4 million/year for 3 years for WMA C soil characterization based on FY08 dollars.
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[1] If sampling for organic compolunds are not detected in first five probeholes, schedule is as shown, however, if found, scheluld is severly impacted and made longer.
[2] Will only take 3 months to do, but do not know when contractor will begin.
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[4] Begins when soil sample analyses are avaliable and ends one month after last soil sampling analysis is complete.
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[6] Anticipated WMA C Performance Assessment Schedule based on Ongoing Working Sessions with Regulators, NRC, Tribal Nations, and other interested stakeholders.
[7] Additional engineering studies may be needed, but will need the soil analyses to provide meaningful input to those studies.
[8] Work to be completed by Plateau Remediation Contractor. This is an integration with DOE-RL and the PRC.

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Attachment 2

Sampling and Analysis Plan for Phase 2 Characterization of Vadose Zone Soil in Waste Management Area C,
RPP-PLAN-38777,
Revision 2

RPP-PLAN-38777
Revision 2~~1~~

SAMPLING AND ANALYSIS PLAN FOR PHASE 2 CHARACTERIZATION OF VADOSE ZONE SOIL IN WASTE MANAGEMENT AREA C

A~~M~~. M~~P~~. Templeton~~Connelly~~

Date Published
June~~August~~ 2010~~9~~

washington river
protection solutions

Prepared for the U.S. Department of Energy
Office of River Protection

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Abbreviations and Acronyms

AEA	Alpha energy analysis
Bgs	Below ground surface
CAS	Chemical Abstracts Service
COPC	Constituents of potential concern
CVAA	Cold vapor atomic absorption
DOE	U. S. Department of Energy
DQO	Data Quality Objectives
Ecology	State of Washington Department of Ecology
EPA	U. S. Environmental Protection Agency
GC/ECD	Gas chromatography/electron capture detection
GC/FID	Gas chromatography/flame ionization detection
GC/MS	Gas chromatography/mass spectrometry
GEA	Gamma energy analysis
HASQARD	Hanford Analytical Services Quality Assurance Requirements Documents
HEIS	Hanford Environmental Information System
HRGC/HRMS	High resolution gas chromatography/high resolution mass spectrometry
IC	Ion chromatography
ICP/AES	Inductively coupled plasma/atomic emission spectroscopy
ICP/MS	Inductively coupled plasma/mass spectrometry
LCS	Laboratory control sample
QA	Quality assurance
PCB	polychlorinated biphenyls
QC	Quality control
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and analysis plan
SGE	Surface geophysical exploration
SST	Single-shell tank
SVOA	Semi-volatile organic analysis
SVOC	Semi-volatile organic compound
TBD	To be determined
TIC	Tentatively identified compound
TBP	tributyl phosphate
UPR	Unplanned release
VOA	Volatile organic analysis
VOC	Volatile organic compound
WAC	Washington Administrative Code
WIDS	waste information data system
WMA	Waste management area

1.0 SAMPLING AND ANALYSIS OBJECTIVES

This sampling and analysis plan (SAP) specifies requirements for field sampling, laboratory analysis, and data reporting for soil samples that will be taken in and around Waste Management Area C (WMA C). The requirements are based on objectives developed using a data quality objective (DQO) process. Results of the DQO process are documented in RPP-RPT-38152, *Data Quality Objectives Report —Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study*. The State of Washington Department of Ecology (Ecology), the U. S. Department of Energy (DOE), and its contractors participated in the DQO process. This SAP and RPP-PLAN-39114, *RCRA Facility Investigation/ Corrective Measures Study Work Plan for Waste Management Area C* provide information that is consistent with guidelines for contents as described in Washington Administrative Code (WAC) 173-340-820, "Sampling and Analysis Plans."

More specifically, this SAP provides overall requirements for soil characterization that will be performed to support development of a Resource Conservation and Recovery Act (RCRA) facility investigation/corrective measures study for WMA C. In addition to information in this SAP, operational details will be needed to perform field sampling and laboratory analysis of the samples. Operational instructions and a summary of requirements will be provided to performing organizations in the forms of sampling and analysis work instructions. These operational documents will meet requirements in this SAP and will be provided to Ecology for information prior to sample collection.

As stated in the DQO, information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the *Atomic Energy Act of 1954*, as amended) is not provided in this SAP for the purpose of regulating the radiation hazards of such components under the authority of this SAP or the "Hazardous Waste Management Act" (70.105 RCW), but is provided for informational purposes only.

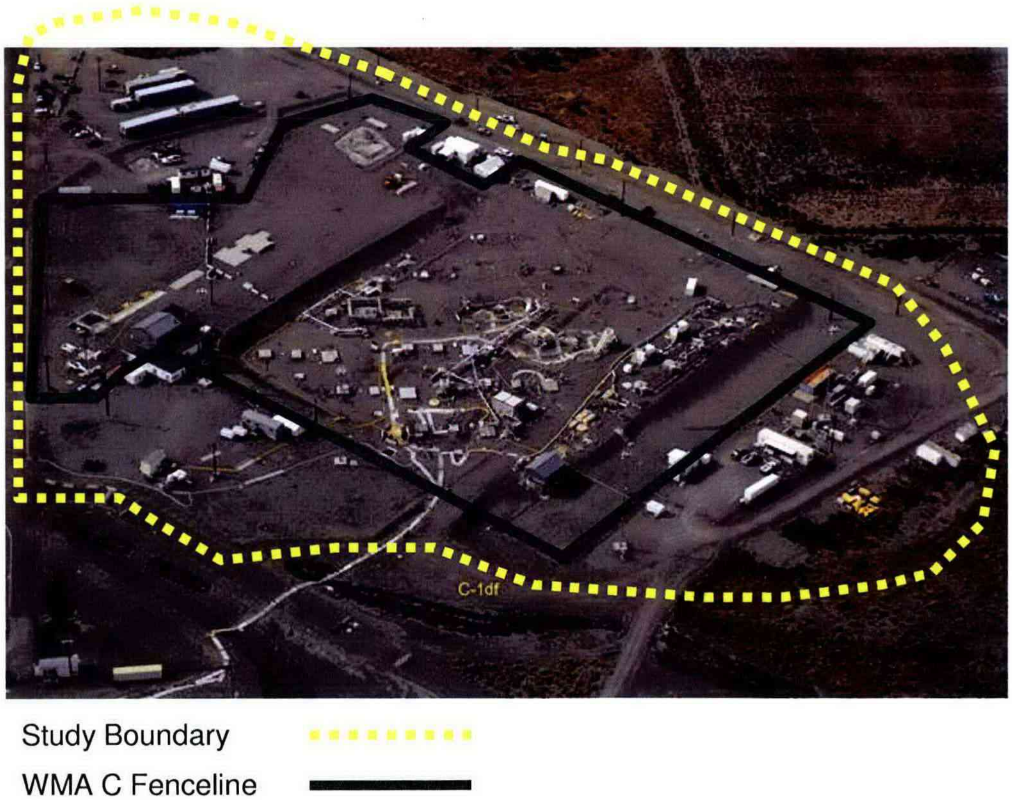
This SAP addresses only characterization of soil contaminants identified in the DQO process as documented in RPP-RPT-38152. Requirements for collecting biological data (e.g., tissue sample data) for an ecological risk assessment and obtaining other input data for the facility investigation/corrective measures study are provided in RPP-PLAN-39114.

2.0 FACILITY DESCRIPTION

Waste Management Area C encompasses the 241-C tank farm located in the east central portion of the 200 East Area. It includes equipment, soil, and groundwater contaminated by C Farm operations. In general, the WMA C boundary is represented by the fence line surrounding the C farm tanks. The boundary for vadose zone soil sampling, as defined by the DQO, includes the WMA and the immediate surrounding areas (See Figure 2-1).

A description of the equipment, soil, and groundwater in WMA C is provided in Section 2 of RPP-PLAN-39114. Section 2 also provided information on past unplanned releases of contaminants in this area. In general, the tank waste contaminants in the WMA C vadose zone soil are expected to originate from these releases.

Figure 2-1. Aerial Boundary of Waste Management Area C and Data Quality Objectives Study Area



3.0 SAMPLING REQUIREMENTS

Surface and subsurface soil samples will be taken and analyzed as part of this characterization effort. Sample analysis results will be used to evaluate human health and ecological risks. Prior to implementing sampling activities, surface radiation surveys will be conducted to identify areas of surface contamination that might affect soil sampling activities and health and safety of workers. Geophysical surveys such as ground penetrating radar will be conducted prior to subsurface sampling to verify buried equipment and identify subsurface anomalies. In addition to soil sampling, surface geophysical exploration (SGE) will be performed. Results from soil samples and SGE will be used to evaluate nature and extent of contaminants. Detailed descriptions of and requirements for these survey techniques are provided in Section 4 of RPP-PLAN-39114.

3.1 SUBSURFACE SAMPLING

3.1.1 Sampling Technique

After completion of geophysical survey(s), identified sites will be investigated by the use of a small diameter single tubing string. This tubing will be pushed to the target depth or refusal and geophysically logged with bismuth germanium~~inate~~ oxide or sodium iodine, and gamma and neutron-neutron moisture instrumentation. The logging data will be reviewed by technical personnel to determine sample collection points. At each sample location, the initial push of approximately 200 feet will be performed. The exploratory push hole will be decommissioned per applicable WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," requirements (e.g., filled with bentonite or bentonite/cement grout as required) as the push tubing is extracted. An average of seven samples per location is planned: three in the top 15 ft (not including a surface sample) and four below 15 ft. After the depths of individual samples are selected, a second push at approximately the same location will be performed. Soil samples will be selected from the pre-determined depths and sent to laboratories where the samples will be analyzed according to the two-step approach described in Section 4.1. If necessary, a third push will be performed to collect samples for some Step 2 analyses. Direct push sampling techniques are described below.

Single-String Sampling System: The single-string sampling system consists of three stainless steel liners contained within a sampler body that is deployed by small-diameter push rods. The three liners are each 4.22 cm (1.66 in.) outside diameter x 3.89 cm (1.53 in.) inside diameter x 15.24 cm (6 in.) long. The probe driving equipment is positioned at the appropriate location and the sampler is advanced to the targeted depth. By use of a key release mechanism, the removable tip is released and the open sampler is advanced through the selected sample interval. The entire rod string including the sampler is then retrieved to surface. The sampler is removed from the push tubing and the stainless steel liners are extracted from the sampler mechanism. The sampling push hole is then re-entered with push tubing and decommissioned per WAC 173-160 requirements.

Dual-String Sampling System: The dual-string sampling system consists of inner and outer strings that are deployed by small-diameter push rods. When the targeted sampling depth is achieved, the rods are pulled back and the removable tip is removed from the inner rods. A sampler is attached to the inner string and returned to the bottom of the outer casing/push tubing and positioned against the inner receiver face of the drive shoe. The inner and outer tubing strings are "locked" together by use of a proprietary method, and the entire assembly is advanced through the targeted sample interval.

The sampler body holds three stainless steel liners. The liners are removed from the sampler body and surveyed. Trained sample-handling technicians document recovery, sample condition, and volume recovery percent. They then package and transport the sample under chain-of-custody control to the selected laboratory for analysis. The "dummy" tip is reattached to the inner string and returned to bottom and placed in the casing shoe, and the entire assembly is advanced to the next designated sample depth. This process is repeated until all sample depths are achieved or the tubing meets refusal.

Upon completion of the final sample extraction, or upon meeting refusal, the dummy tip or sampler is removed and the borehole is decommissioned per WAC 173-160 requirements.

3.1.2 Sampling Strategy

The s~~S~~ampling strategy at each vertical direct push site is summarized below (RPP-ENV-38838, *Tank Farm Vadose Zone Program Characterization Processes*). Note that the specified depths are only approximate and are subject to constraints in the field.

1. At each site, a minimum of two direct push probe holes pushes will be completed. The initial probe hole is logged for both gross gamma and neutron moisture. Following logging, deep electrodes are installed for SGE. The second push is for soil sampling based on the data derived from the first push.

2. The depth of the first push will be no greater than 200 ft below ground surface (bgs) or refusal at all sites except H, I, and S (See Table 3-1). This target depth is based on the observation of ^{99}Tc and nitrate at 160 ft bgs at borehole C4297 and ^{60}Co between 150 and 160 ft bgs at well 299-E27-4. The depth at site S will be to 260 ft bgs or refusal based on ^{60}Co detected at nearby well 299-E27-14. It is expected that the direct push method can reach these depths based on three pushes of 200 ft bgs or more at unplanned releases (UPRs) 81 and 86.

3. At sites H and I, the depth of the direct push will be 15 ft unless data from sites F and G indicate that the direct pushes at sites H and I should be deeper.

4. Deep electrodes are placed at the base of the initial probe hole and at a depth of approximately 55 ft bgs.

5. For the second probe hole at depths less than 15 ft bgs, three samples are targeted to be taken at 5-, 10- and 14-ft bgs in the vadose zone. These depths are only approximate and were selected such that they are somewhat evenly spaced apart. The purpose of collecting samples in the first 15 ft is to provide data for the direct exposure pathway and to provide initial data for ecological risk.

Table 3-1. Sampling Design (3 sheets)

Sampling Site Designation	Location	Deployment	Number of Direct Pushes	Average Number of Samples per Direct Push	Number of Surface Samples	Known or Suspected Event	Access Availability	Planned Analyses
A	Spare inlet 241-C-101	Direct push, slant; Surface grab	1-2	7	1 sample plus one collocated duplicate	Tank over fill. Loss through spare inlet	Fair	Step 1 analyses (and Step 2 analyses if necessary)
B	241-C-101, south side	Direct push, vertical or slant; Surface grab	1	7	1 sample plus one collocated duplicate	Tank release	Good	Step 1 analyses (and Step 2 analyses if necessary)
C	241-C-203	Direct push, slant; Surface grab	3	3: 0-15 ft 15: >15 ft	1 sample plus one collocated duplicate	Tank leak and/or tank over fill. Loss through spare inlet	Fair	Step 1 analyses (and Step 2 analyses if necessary)
D	241-C-201 241-C-202 241-C-204	Direct push, slant; Surface grab	1-2/tank	7	1 sample plus one collocated duplicate	200 series tank leaks	Fair	Step 1 analyses (and Step 2 analyses if necessary)
E	Between 241-C-106 and 200-C-109	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Suspected release	Fair	Step 1 analyses (and Step 2 analyses if necessary)
F	Building C-801 chemical drain	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Suspected release site	Good	Step 1 analyses (and Step 2 analyses if necessary)
G	Between Building C-801 and 241-C-103	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Suspected transfer line release site	Good	Step 1 analyses (and Step 2 analyses if necessary)
H	Northeast side of E-91	Direct push, vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Surface release	Good	Step 1 analyses (and Step 2 analyses if necessary)
I	Northeast side of E-115	Direct push, vertical or slant; Surface grab	1	7	1 sample plus one collocated duplicate	Surface release	Good	Step 1 analyses (and Step 2 analyses if necessary)
J	241-C-104	Direct push, slant; Surface grab	1	7	1 sample plus one collocated duplicate	Tank release	Fair	Step 1 analyses (and Step 2 analyses if necessary)

Table 3-1. Sampling Design (3 sheets)

Sampling Site Designation	Location	Deployment	Number of Direct Pushes	Average Number of Samples per Direct Push	Number of Surface Samples	Known or Suspected Event	Access Availability	Planned Analyses
K	241-C-108	Direct push, vertical or slant; Surface grab	1	7	1 sample plus one collocated duplicate	Transfer line leak, hot dry well (09-02)	Poor	Step 1 analyses (and Step 2 analyses if necessary)
L	241-C-103 and 241-C-106	Drywell logging and direct push, vertical; Surface grab	2	7	1 sample plus one collocated duplicate	Potential transfer line leak and tank over fill	Fair	All analyses listed in Section 4.0
M	241-C-104, 108, 109, 110, 111, and 112	Drywell logging	NA~~0~~	NA~~0~~	NA		Fair to Good	NA
N	UPR-86, UPR-82 and UPR 81	SGE	NA~~Use existing network~~	NA	NA		Good	NA
O	WMA C	SGE	NA~~TBD supplement existing network~~	NA	NA		Good	NA
P	UPR-81	Balance of direct pushes to complete characterization; Surface grab	3	7	1 sample plus one collocated duplicate	Known release site	Good	All analyses listed in Section 4.0
Q	UPR-82	(1) 4 adjacent direct pushes to support placement of strings of deep electrodes for 3D SGE per Sampling Site Designation N; (2) Direct push through center depending on SGE results;~~of UPR-82~~ Surface grab[1a]	1	7	1 sample plus one collocated duplicate	Known release site	~~Good~~Poor due to shotcrete cover	Step 1 analyses (and Step 2 analyses if necessary)

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Table 3-1. Sampling Design (3 sheets)

Sampling Site Designation	Location	Deployment	Number of Direct Pushes	Average Number of Samples per Direct Push	Number of Surface Samples	Known or Suspected Event	Access Availability	Planned Analyses
R	241-C-301 Catch Tank	Direct push vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Unlined concrete catch tank	Good	Step 1 analyses (and Step 2 analyses if necessary)
S	UPR-72 and C-8 Drain	Direct push vertical; Surface grab	1	7	1 sample plus one collocated duplicate	Buried radioactive material and French drain from 241 CR Building are in this area	Good	Step 1 analyses (and Step 2 analyses if necessary)
T	TBD, based upon SGE data for entire WMA	TBD, direct push vertical and/or slant	TBD	7	1 sample plus one collocated duplicate	Previously unknown release sites	TBD	Step 1 analyses (and Step 2 analyses if necessary)
U	C-110	Direct push, slant or vertical	1	7	1 sample plus one collocated duplicate	Characterize C-110 release and conceptual Model 1 and alternate Models 1 & 3	Fair	Step 1 analyses (and Step 2 analyses if necessary)
V	C-111	Direct push vertical	1	7	1 sample plus one collocated duplicate	Characterize C-111 release and conceptual Model 1 and alternate Models 1 & 3	Good	Step 1 analyses (and Step 2 analyses if necessary)
W	~~299-E27-4,~~ 299-E27-12, 299-E27-13, 299-E27-14, 299-E27-15	Log groundwater monitoring wells outside of WMA C	NA~~0~~	NA	NA	Log wells to collect data on U, ^{60}Co, ^{137}Cs and moisture	Good	NA

[~~1~~a] Sampling design details for Sampling Site Designation Q are applicable to the single direct push that may be undertaken for sampling. Additional probe holes will be placed to support logging/electrode placement.

TBD = to be determined.

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6. For depths greater than 15 ft bgs, the depth location for sampling individual horizons will be selected by reviewing the gamma and moisture logs of the first direct push and the following information: any leak loss inventory information pertinent to the site, geologic summary of the area, operational history, and historical characterization data at that site. The selection of sampling horizons will be done in an open meeting in which Tank Operation Contract staff, DOE, Ecology, U.S. Environmental Protection Agency, and other site contractors are invited.

The sampling strategy for the sites with slant probe holes is the same as for vertical probe holes with the following exceptions:

1. The angle of the slant probe hole will be determined after ground penetrating radar survey has been completed.

2. The length of slant direct pushes at the C-100 series tanks will be no greater than 200 ft total length (inclined path) of the slant probehole or refusal, while for the C-200 series tanks the length will be no greater than 160 ft total length (inclined path) of the slant probehole or refusal. The exact length depends upon the setup location and the angle of the direct push. The goal of the probe holes is to determine if tank fluids have leaked into the environment. The target zone for sampling is between 5 and 10 ft below tank bottom. Additionally, the direct push probe holes placed at the C-200 series tanks will be extended to sample soils beneath the pipelines running between the C-200 series and the C-100 series tanks.

3. For slant probe holes, three soil samples (direct exposure and ecological risk) will be taken in the upper 15-ft of the vadose zone. The location along the length of these probe holes will be determined by the angle of the probe hole, but samples will be collected at approximately 5-, 10-, and 14- ft bgs. Deeper samples will be taken using the same method as outlined in step 5 of the vertical probe holes.

4. One deep electrode will be installed at the base of the initial slant probe hole.

If contamination is found in any of the soil sampling probe holes at their total depth, additional characterization technologies may be deployed upon agreement from Ecology to define the maximum depth of contamination. Sampling below the 200 ft bgs probably will require a borehole. If drilling of the borehole extends all the way into groundwater, Ecology and DOE will meet to determine if a groundwater well will be installed at the location or if the borehole will be decommissioned in accordance with WAC 173-160.

3.2 SURFACE SAMPLING

Surface soil samples will be taken at the sites where direct push samples are planned (see Table 3-1). Soil in the top 12 inches will be collected using spatula, scoop, or miniature core samplers. The samples will be sent to laboratories where they will be analyzed according to a two-step approach as described in Section 4.1. Although every attempt will be made to collect this sample, the gravel surface in tank farms may prevent taking a sample that contains environmentally sensitive media (i.e., soil particles less than 2 mm in diameter). If this is the case, pictures of the sampling site showing the gravelly nature of the land surface and the reason as to why a sample will not be taken will be documented in borehole/site completion reports.

3.3 SOIL SAMPLING DESIGN

3.3.1 Sample Number and Locations

A random sampling approach cannot be applied in WMA C because of the extensive amount of interferences caused by buried infrastructure and topographic constraints. Also, significant knowledge exists regarding locations and sources for known and suspected releases in and around WMA C. Therefore, a non-probabilistic (biased) sampling strategy that targets locations where contaminants are most likely to be encountered will be employed. This approach provides the highest potential for confirming and characterizing these known and suspected releases. In addition, an attempt will be made to identify any unknown releases by using SGE across the entire tank farm. SGE will be used as an alternative technique to random sampling for investigating unknown releases because, regardless of infrastructure interference, the target area is simply too large to permit, in terms of time and resources, a statistically valid random sampling effort.

Candidate sample locations are identified in the WMA C DQO (RPP-RPT-38152). Rationale for selecting sample locations is described in detail in Section 4.4 of RPP-PLAN-39114. Figure 3-1 shows the location of known and suspected releases in and around WMA C and the location of the candidate sample sites. Figure 3-2 shows the candidate sample locations in relationship to existing surface features and Figure 3-3 shows the candidate sample locations relative to subsurface interferences. The final sample locations will be established based on collected geophysical data and facility walkdowns conducted prior to deployment of the sampling equipment to the sample site. Table 3-1 presents a general description of the candidate sampling locations.

A number of locations are expected to require a slant direct push. These locations are associated with the single-shell tank (SST) C-101 (site A), C-104 (site J), C-110 (site U), and the C-200 tanks (sites C and D). Target areas are beneath the spare inlet nozzles on these tanks which are suspected to be a release site from tank overfilling. In addition, pipelines and cascade lines are targeted which could have produced releases adjacent to these tanks. Target areas and associated depth of samples are further defined in the WMA C Work Plan. Four samples will be collected in the top 15 ft (one at the surface and one each at 5 ft, 10 ft and 14 ft bgs) at each location and up to four additional samples will be collected at depths >15 ft.

At C-203, three slant direct pushes will be made and a total of 15 samples (averaging 5 per direct push) will be collected at depths >15 ft bgs. The remaining C-200 series tanks will each have one direct push with a minimum of 4 samples taken at depths greater than 15 ft bgs. If data indicate a release occurred then two slant direct pushes at each of the remaining C-200 tanks will be made to collect vadose zone samples.

At each of the direct push locations, an array of SGE electrodes will be placed in anticipation of conducting an SGE evaluation of the entire tank farm.

Figure 3-1. Candidate Sample Locations and Surface Geophysical Exploration Interrogation Areas

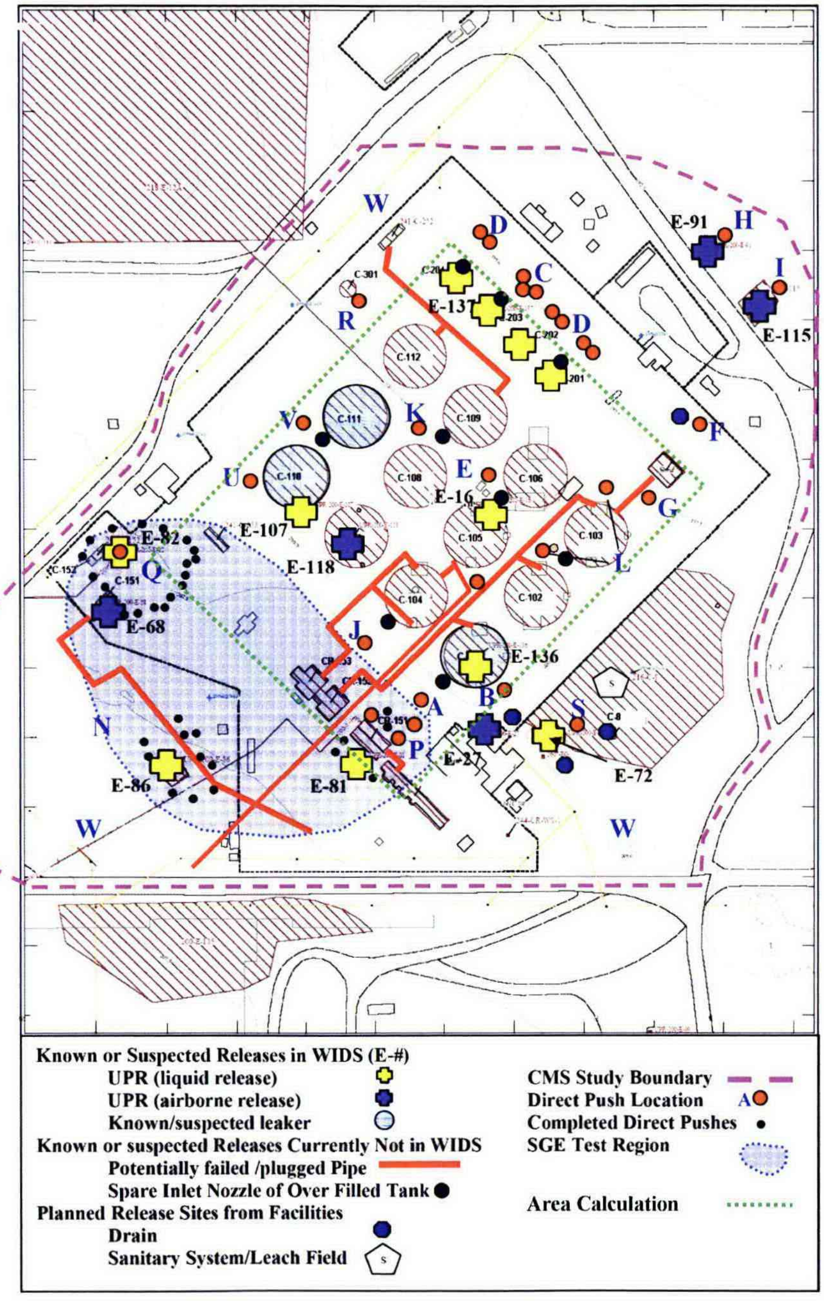
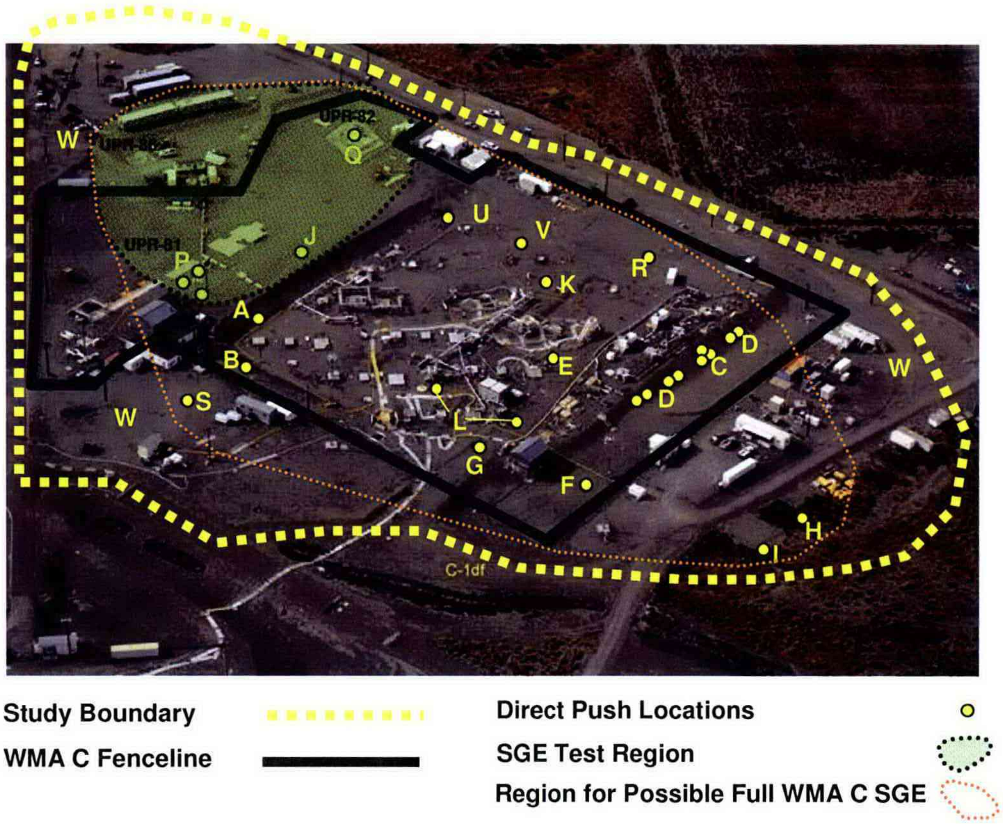


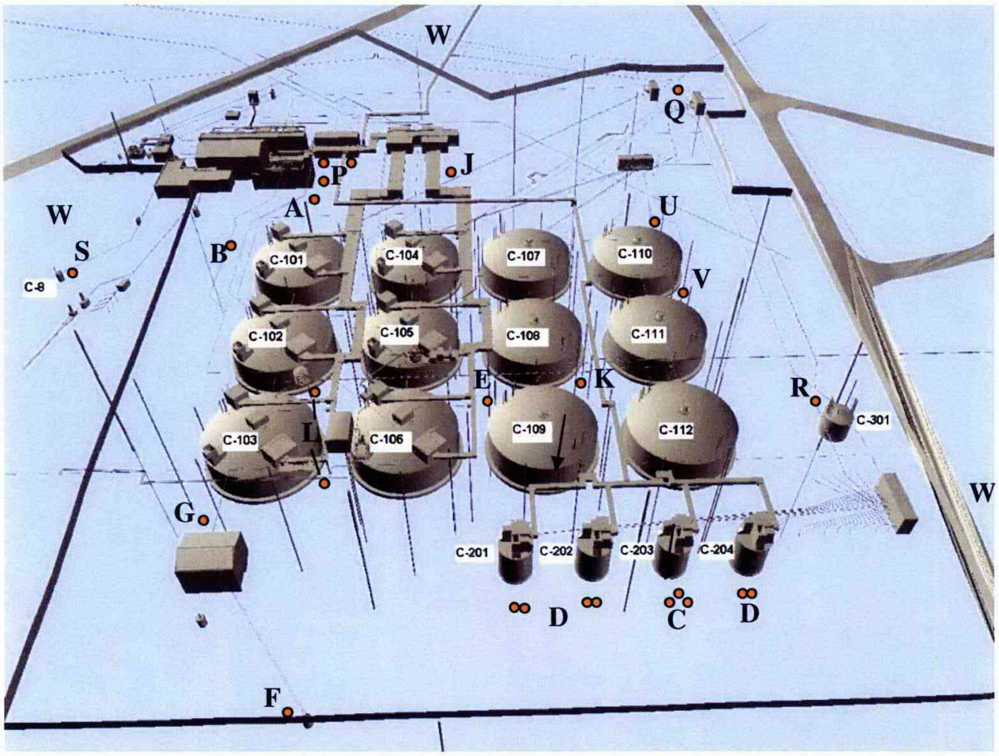
Figure 3-2. Aerial Map of Candidate Sample Locations and Surface Geophysical Exploration Interrogation Areas on Aerial Map



3.4 SAMPLE HANDLING AND SHIPPING

Whenever possible, soil samples shall be maintained and shipped at 4 degrees Celsius. The samples shall be shipped to the laboratory as soon as possible to meet applicable holding times. However, it is recognized that some samples may have elevated levels of radioactivity. These samples must be stored and transported in shielded shipping containers that may not allow the samples to be maintained at 4 degrees Celsius. Also, fewer samples may be shipped to the laboratory in a shipment. The additional shipments may jeopardize sample holding times recommended in SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*. To minimize impact on sample integrity, these highly radioactive samples shall not be exposed to high temperatures and they shall be shipped to the laboratory for analysis as soon as possible. Samples not meeting temperature or holding time requirements shall be discussed in the laboratory data report. The impact on subsequent use or interpretation of these data will be evaluated on a case-by-case basis by the Tank Operation Contractor.

Figure 3-3. Candidate Sample Locations and Infrastructure Constraints



Radiological control technician(s) will measure contamination levels on the outside of each sample jar and dose rates on each sample jar. The radiological control technician(s) also will measure radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR, "Transportation") and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria.

3.5 SAMPLE IDENTIFICATION

A sample and data-tracking database will be used to track the samples from the point of collection through laboratory analysis process. The Hanford Environmental Information System (HEIS) database will be the repository for the laboratory analytical results. HEIS sample numbers will be issued to the sampling organization for this project in accordance with onsite organizational procedures. Each radiological/nonradiological and physical properties sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed water-resistant labels:

- Sample identification number
- Sample collection date and time
- Name or initials of person collecting the sample
- Preservation method (if applicable)
- Sample location (direct push hole number and depth of collection).

A list of sample analyses is not required for sample labels because the list could be quite large. The laboratory will consult the sampling and analysis work instruction document(s) for appropriate analyses and additional guidance for preparing the sample for analysis.

3.6 SAMPLE CUSTODY

A chain-of-custody form shall be used for each sample and will accompany each sample from sampling through analysis. At a minimum, the following sampling information shall be included on the chain-of-custody form:

- Project name
- Signature of the collector
- Date and time of collection
- Sample type (e.g., soil, etc.)
- Requested analysis or provide a reference for sample analysis
- Signatures of persons involved in the chain of possession
- Date and time relinquished to the laboratory
- Unique sample identification number assigned to the sample
- Sample location (direct push hole number and depth of collection)
- A notation of pertinent sampling information including unusual characteristics or sampling problems
- A brief description of the sample matrix such as color or consistency if possible.

Each sample will be shipped to the laboratories in an approved shipping container per approved procedure. A custody seal will be affixed to the lid of each sample container.

4.0 SAMPLE ANALYSIS REQUIREMENTS

Note that in this SAP, the specified U. S. Environmental Protection Agency (EPA) SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, analytical methods are shown without suffices indicating method revisions. For these methods, the most recent revisions are preferred.

4.1 OPTIMIZATION OF SAMPLE ANALYSIS

Based on Phase 1 soil sampling results, it is expected that many of the soil samples that will be collected in Phase 2 are not contaminated. Therefore, sample analyses will be optimized so that the use of limited laboratory resources would weigh more heavily toward samples that are contaminated. More specifically, a limited set of analyses will be performed on each sample to determine if the sample is contaminated. If a sample is determined to be so, more extensive analyses will be performed on the sample. This two-step optimization approach is described further in Section 4.1.2.

In addition, organic contaminants are not expected to be present in the WMA C vadose zone soil samples in significant amounts. Organic analyses will be performed on samples to be collected from 5 sites. Results will be used to determine if certain organic analytes should be removed from the list of constituents-of-potential-concern (COPCs). The organics optimization approach is described in Section 4.1.1. A flow diagram for the overall optimization of sample analyses is provided in Figure 4-1.

4.1.1 Organic Analyses Optimization

Five of the twenty-seven sites identified for characterization have been selected to evaluate potential for organic contamination. The five candidate direct push sites are associated with UPR-81 (three locations) (site P) and on the northwest and northeast side of SST C-103 (2 locations) (site L). For these two sites, the waste information data system (WIDS) indicates that the release occurred in the waste transfer line near the 241-CR-151 Diversion Box on October 15, 1969. The release is associated with the 241-CR-151 Diversion Box, the 241-C-102 tank and the PUREX 202-A Building. The source of the release was in an underground transfer line from the 202-A Building to the 241-C-102 tank via the 241-CR-151 diversion box. LAUR-93-3605, *Analysis of the History of 241-C Farm* states:

"An organic layer was noted in C-102 in 1969 and reported (Anderson, T. D. "Organics in 102-C Tank," letter to W. L. Godfrey, October 2, 1969) to be 36 kgal. This organic layer was subsequently transferred to C-103 in a P-10 pumping of C-102 in 1975. There is a recorded transfer of 111 kgal in '75-4, but the level change in C-102 indicated that only 25 kgal was transferred, with another 8 kgal in '78-3, for a total of 33 kgal. Presumably, this combined 33 kgal transfer was largely the organic layer, and would have left 3 kgal in C-102."

Figure 4-1. Optimization of Sample Analyses (2 sheets)

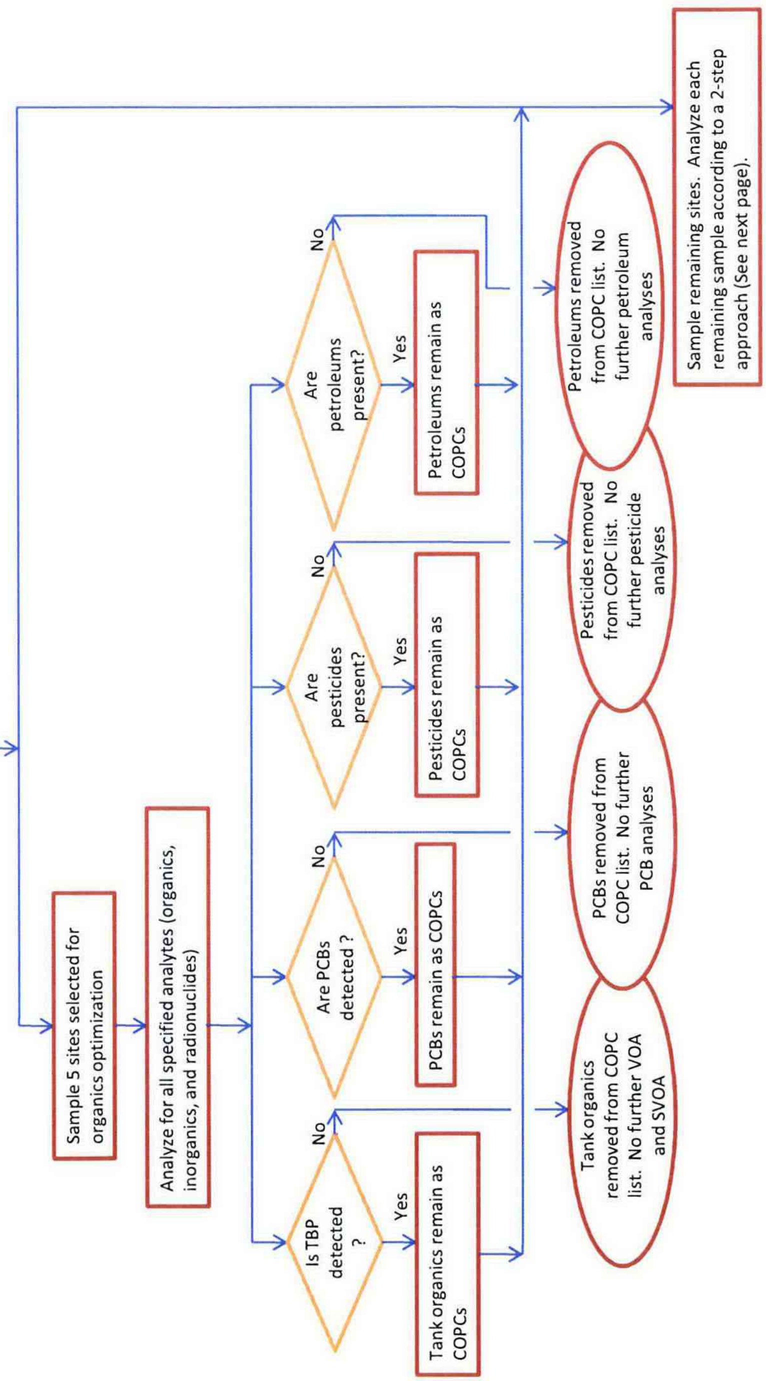
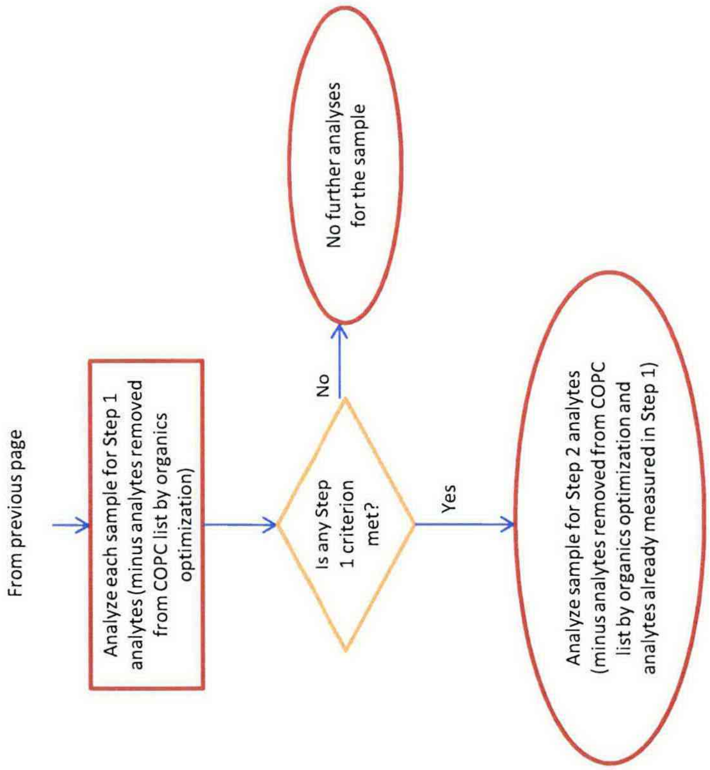


Figure 4-1. Optimization of Sample Analyses (2 sheets)



The event description in RPP-PLAN-39114 Rev. 1 Table 2-8 for row Date = 3-1965 Waste Type = PUREX CWP2 is given below.

"A liquid level rise in Tank 103-C, the cesium feed tank, was apparently caused by a failed line in the encasement between the 152-CR diversion box and Tank 102-C which permitted coating waste from the PUREX Plant to leak into the encasement and drain to Tanks 101-C, 102-C, and 103-C via the tank Pump pits. Coating waste has been routed through a spare line to Tank 102-C and no further leaks have been detected. The coating waste solution accumulated in Tank 103-C did not significantly affect cesium loading capability as a cask was loaded normally following the incident.

Note: Pipeline 8041 is inside a concrete encasement was used to route the PUREX CW to SST C-102 (see drawing H-2-44501, sheet 92). This encasement traverses from diversion box 241-CR-152 along the west side of SSTs C-101, C-102, and C-103. In order for the PUREX CW to drain into SSTs C-101, C-102, and C-103, the encasement containing the failed transfer pipeline must have partially filled with waste. The integrity of this encasement is unknown and may have leaked waste to the soil. Drawing H-2-2338, sheet 45 indicates pipeline 8041 is out of service. Pipeline 8041 connects from nozzle U-3 in the 241-CR-152 diversion box and nozzle U-2 in pit 02C atop SST C-102."

Based upon this information it would appear that the potential exists that more than one release may have occurred in and around CR-151, CR-152 and C-101/102/103 tanks from 1965 to 1969. While waste is referenced as PUREX coating waste in WIDS or PUREX cladding waste in RPP-PLAN-39114, the presence of organics is documented in tank C-102 during this time frame. While these data are inconclusive that a release of organic contaminated wasted occurred, the rationale for selecting sites in the DQO was to identify areas of known or suspected releases having some potential for containing organic contamination. It was felt that sample locations "L" and "P" satisfied these criteria; these are located at each end of the encasement.

At these five locations, following the spectral gamma and neutron logging, samples will be collected and analyzed for the entire suite of analytes. Tributyl phosphate (TBP) will be used as the indicator organic for the occurrence of any organic contamination associated with tank waste. Tributyl phosphate is a known tank waste contaminant because it was used extensively as a solvent in the reprocessing of spent nuclear fuel. Tributyl phosphate was chosen because it has the highest probability of being found. It is the only organic constituent other than acetone and 2-Butanone found above detection limits in all tank residual samples and it is found at higher concentrations 75 to 73,000 μg/g (mg/kg) which is 10 to 100,000 times higher than all other organics including polychlorinated biphenyls (PCB). It was presented during the DQO process that if TBP is not found then it is unlikely that other organic (i.e., volatile organic analysis [VOA], semi-volatile organic analysis [SVOA], diesel range organics/gasoline range organics, PCBs) contaminants related to tank waste would be found. The DQO team agreed to use this compound as an indicator for tank waste organics.

Furthermore, if the data for the organic analytes from the pre-retrieval samples taken at the C-200 Tanks is examined, the Best Basis Inventory reports the following organic analytes were found above the MDL in the pre-retrieval samples: Butylbenzylphthalate, 1-Butanol, Acetone, Aroclor 1254, 2-Butanone, Xylenes (total), Xylene (m & p), Trichloroethene, Xylene (o), Hexone, Methylenechloride, and Toluene. The mean concentrations for Butylbenzylphthalate, 1-Butanol, and Acetone were 66.7 µg/g, 16.8 µg/g, and 1.01 µg/g, respectively. The only PCB above MDL was Aroclor-1254 with a mean concentration of 0.46 µg/g. 2-Butanone had a mean concentration of 0.29 µg/g, with the rest of the non-detected organic analytes having a mean concentration of less than 0.1 µg/g. Tri-butyl phosphate was found as a tentatively identified compound (TIC) in the pre-retrieval samples from tanks C-203 and C-204 with the highest concentration found at C-204 at greater than 200,000 µg/g. Tri-butyl phosphate in the post-retrieval samples for these tanks had results ranging from ~5,000 mg/kg (C-201) to ~73,000 mg/kg (C-204).

Other organic compounds found above detection limits in some, but not all tank residuals, are Butylbenzylphthalate (3.27 mg/kg (C-103)), Di-n-butylphthalate (6.11 mg/kg C-103, 6.08 mg/kg C-204), Hexone (2.27E-02 mg/kg C-202), and Xylenes (Total) (2.0E-02 mg/kg C-203).

If TBP is not detected in any of the samples then organics associated with tank waste will be eliminated from the list of COPCs and samples taken at other locations in WMA C will not be analyzed for organics. If TBP is detected in any of the samples then organics associated with tank waste will remain on the list of COPCs and these organic compounds will be analyzed as part of the Step 2 suite of analytes if a Step 1 tank waste indicator is met. Tributyl phosphate is selected as a specific tank waste contaminant. Other volatile and semivolatile compounds are rejected as either not being indicators of tank waste or are common laboratory contaminants.

Samples taken from the five sites will be analyzed for pesticides and petroleum compounds. If pesticides are not present in any of the samples from these sites, then pesticides will be eliminated from the list of COPCs and other soil samples that will be taken from WMA C will not be analyzed for these compounds. If a pesticide is present in any of the samples from the five sites, then pesticides will remain on the list of COPCs for Step 1 analyses.

Similarly, if gasoline-range organics and diesel-range organics are not present in any of the samples from the five sites, these petroleum organics will be eliminated from the list of COPCs. If they are present in any of the samples, gasoline-range organics will remain on the list of COPCs for Step 1 analyses of near surface samples; diesel-range organics will be analyzed by gas chromatography/flame ionization detection (GC/FID) only if gas chromatography/mass spectrometry (GC/MS) indicates that they are present in a sample.

Polychlorinated biphenyls are of specific concern to direct contact and ecological risk and will be analyzed in near surface samples only. Three vadose zone samples will be collected in the region of 0 to 15 ft bgs at the five direct push locations discussed above (15 samples) and analyzed for Aroclors and congeners. If polychlorinated biphenyls are not detected in any of the samples then they will be eliminated from the list of COPCs and will not be analyzed at other locations in WMA C. If polychlorinated biphenyls are detected in any of the samples then they will remain on the list of COPCs and will be analyzed as part of the Step 2 suite of analytes following a detection of the Step 1 tank waste trigger constituents. Results from the initial five samples will be used in an attempt to establish a correlation between PCB Aroclors and congeners. The correlation will be used to evaluate whether or not future analysis of PCB congeners is necessary.

Note: The WMA C DQO identifies sites P and L as candidate sites where samples will be collected for organic optimization. Before sampling soils at other candidate sites, organic analyses on samples taken from sites P and L should be completed to evaluate if further organic analyses at the other sites are warranted. However, while preparing this SAP, tank farm schedule was modified to include retrieval of waste in the 244-CR Vault. The waste retrieval activity is expected to restrict access to site P. Furthermore, above ground infrastructure near tank 241-C-103 may prevent early sampling at site L. Therefore, discussions with DOE and Ecology will be initiated during the Ecology review of this SAP to identify different sampling sites within WMA C boundary for organic optimization.

4.1.2 Two-Step Sample Analyses Optimization

In accordance with the WMA C DQO, sample analysis will be performed using a two-step approach to optimize cost-effectiveness. Step 1 will employ a method-based screening process to determine if the soil has been contaminated with tank waste. A select set of threshold indicator constituents will be used to indicate the presence of tank waste. The criteria for selecting these "threshold indicator constituents" are based on them being historically associated with tank waste, indicative of tank farm constituents released into the environment and drive human health risk, and were the most detected constituents in Phase 1 investigations. If any one of the tank waste indicator threshold is met, then samples at that location will be analyzed for the full suite of Step 2 analytes. The Step 1 analytes and their threshold values are as follows:

^{238}U	Detected at or above 1.39 pCi/g
^{239}Pu	Detected at or above 0.0233 pCi/g
^{137}Cs	Detected at or above 1.37 pCi/g
^{90}Sr	Detected at or above 0.262 pCi/g
NO_3 (as NO_3)	Detected at or above 232 µg/g
Cr (for ^{6}Cr)	Detected at or above 26.8 µg/g
^{99}Tc	Detected at the Method Detection Limit
^{129}I	Detected at the Method Detection Limit
Cyanide (CN)	Detected at the Method Detection Limit
TBP	Detected at the Method Detection Limit.

Uranium-238, ^{239}Pu, ^{137}Cs, ^{90}Sr, NO_3, and Cr are present at low level in Hanford background soil. The stated thresholds are met only if the contaminants are detected and the detected concentrations are at or above the stated values. Although elevated pH is an indicator of the passage of tank waste through soil, it may not represent all tank waste contamination pathways as have been indicated in the past (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*). The stepped approach will also be further evaluated following the examination of the sample results from the first five direct pushes. The approach may be modified after consultation with Ecology.

The following methods will be performed on samples to get the above analytes: Inductively coupled plasma/mass spectrometry (ICP/MS) for ^{238}U, ^{239}Pu, and ^{99}Tc; inductively coupled plasma/atomic emissions spectroscopy (ICP/AES) for Cr; ion chromatography (IC) for NO_3; gamma energy analysis (GEA) for ^{137}Cs; separation/beta counting for ^{90}Sr; separation/GEA for ^{129}I; spectrophotometric for cyanide (CN); and SVOA by GC/MS for TBP. Alpha energy analysis (AEA) may be used as an alternative method for ^{239}Pu. Cobalt-60 concentration will be obtained by GEA along with ^{137}Cs. Cobalt-60 and ^{99}Tc sample results will be used to assess the relationship of these radionuclides in the soil.

The above thresholds may not be applicable to a screening of petroleum contaminants. Semivolatile organic analysis (EPA Method 8270) will be used to analyze for TBP in Step 1. This method is also capable of analyzing for diesel-range organics. Results will be used to evaluate whether or not diesel-range organics are present in the soil in significant amounts that requires further analyses for this analyte by another analytical method such as GC/FID (EPA Method 8015). Gasoline-range organics will be analyzed by purge-and-trap GC/MS (EPA Method 8260) in Step 1.

Similarly, pesticide usage is not associated with tank waste generation and storage. Pesticide compounds will be analyzed by gas chromatography/electron capture detection (GC/ECD) (EPA Method 8081) in Step 1.

Petroleum and pesticide data will be used for an ecological risk assessment. Therefore, only samples taken in the near surface zone (i.e., in the top 15 ft) will be analyzed for these organics.

In summary, sample analysis will be performed using a two-step approach. Step 1 analytes and methods are a subset of Step 2 analytes and methods. If a Step 1 threshold is met or exceeded, then all Step 2 methods (minus methods already performed in Step 1) will be performed. Step 2 analytical parameters for major constituent categories (inorganic chemicals, organic chemicals, and radionuclides) are discussed in Sections 4.2 through 4.4.

4.2 INORGANIC ANALYTES

Inorganic chemicals will be analyzed using the following methods: ICP/AES for cations, IC for anions and ammonia, cold vapor atomic absorption (CVAA) for mercury, spectrophotometric analysis for cyanide, ion selective electrode for sulfide, and pH. The ICP/AES and IC methods are capable of analyzing multiple constituents. Primary and secondary constituents for these methods are shown in Tables 4-1 and 4-2.

Table 4-1. Primary Inorganic Constituents and Analytical Methods (2 Sheets)

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Constituent	Analytical Method	Alternate Method
Aluminum – Al	6010 (ICP/AES)	6020 (ICP/MS)
Antimony – Sb	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Arsenic – As	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Barium – Ba	6010 (ICP/AES)	6020 (ICP/MS)
Beryllium – Be	6010 (ICP/AES)	6020 (ICP/MS)

Table 4-1. Primary Inorganic Constituents and Analytical Methods (2 Sheets)

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Constituent	Analytical Method	Alternate Method
Cadmium – Cd	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Calcium[~~2~~a] – Ca	6010 (ICP/AES)	6020 (ICP/MS)
Chromium – Cr	6010 (ICP/AES)	6020 (ICP/MS)
Cobalt – Co	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Copper – Cu	6010 (ICP/AES)	6020 (ICP/MS)
Iron – Fe	6010 (ICP/AES)	6020 (ICP/MS)
Lead – Pb	6010 (ICP/AES)	6020 (ICP/MS)
Lithium[~~2~~a] – L	6010 (ICP/AES)	6020 (ICP/MS)
Manganese – Mn	6010 (ICP/AES)	6020 (ICP/MS)
Magnesium[~~2~~a] – Mg	6010 (ICP/AES)	6020 (ICP/MS)
Molybdenum[~~2~~a] – Mo	6010 (ICP/AES)	6020 (ICP/MS)
Nickel – Ni	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Phosphorus[~~2~~a] – P	6010 (ICP/AES)	6020 (ICP/MS)
Potassium[~~2~~a] – K	6010 (ICP/AES)	6020 (ICP/MS)
Selenium – Se	6010 (ICP/AES)	6020 (ICP/MS)
Silver – Ag	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Sodium[~~2~~a] – Na	6010 (ICP/AES)	6020 (ICP/MS)
Strontium – Sr	6010 (ICP/AES)	6020 (ICP/MS)
Thallium – Tl	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Uranium – U	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Vanadium – V	6020 (ICP/MS)~~6010 (ICP/AES)~~	6010 (ICP/AES)~~6020 (ICP/MS)~~
Zinc – Zn	6010 (ICP/AES)	6020 (ICP/MS)
Mercury – Hg	7470, 7471 (CVAA)	6020 (ICP/MS)
Fluoride – F^-	9056 (IC)	
Nitrite – NO_2^-	9056 (IC)	
Nitrate – NO_3^-	9056 (IC)	
Chloride – Cl^-	9056 (IC)	
Sulfate – SO_4^{2-}	9056 (IC)	
Acetate[b~~1~~] – $C_2H_3O_2^-$	9056 (IC)	
Formate[b~~1~~] – CHO_2^-	9056 (IC)	
Glycolate[b~~1~~] – $C_2H_3O_3^-$	9056 (IC)	
Oxalate[b~~1~~] – $C_2O_4^{2-}$	9056 (IC)	
Cyanide – CN^-	9014 (spectrophotometric)	IC/MS
Ferrocyanide – $Fe(CN)_6^{4-}$	Estimated from total cyanide.	
Sulfide – S^{2-}	9215 (ion selective electrode)	9034 (titration)
Ammonium – NH_4^+	EPA 300.7 (IC)	
pH	9045	

Table 4-1. Primary Inorganic Constituents and Analytical Methods (2 Sheets)

Constituent	Analytical Method	Alternate Method

Abbreviations: CVAA = cold vapor atomic absorption, IC = ion chromatography, ICP/AES = inductively coupled plasma/atomic emissions spectroscopy, ICP/MS= inductively coupled plasma/mass spectrometry, IC/MS=ion chromatography/mass spectrometry

[a] Calcium, lithium, molybdenum, magnesium, sodium, phosphorous, and potassium were moved from secondary constituents to primary at the request of Ecology to help in the evaluation of whether or not tank fluids have passed through the sediments.

~~Note:~~ ~~[1] Acetate~~ [b] Acetate, formate, glycolate, and oxalate are technically organic anions but are included in this table because they can be analyzed by the same method as some inorganic anions. ~~[2] Calcium, lithium, molybdenum, magnesium, sodium, phosphorous, and potassium were moved from secondary constituents to primary at the request of Ecology to help in the evaluation of whether or not tank fluids have passed through the sediments.~~

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Table 4-2. Secondary Inorganic Constituents

Constituent	Constituent
Method 6010 (ICP/AES)	**Method 9056 (IC)**
Boron – B	Bromide – Br^-
Bismuth – Bi	Phosphate – PO_4^{3-}
Calcium – Ca	
Lithium – Li	
Molybdenum – Mo	
Magnesium – Mg	
Sodium – Na	
Phosphorus – P	
Potassium – K	
Rhodium – Rh	
Sulfur – S	
Silicon – Si	
Tin – Sn	
Tantalum – Ta	
Tungsten – W	
Yttrium – Y	
Zirconium – Zr	
Cerium – Ce	
Europium – Eu	
Lanthanum – La	
Niobium – Nb	
Neodymium – Nd	
Palladium – Pd	
Praseodymium – Pr	

Table 4-2. Secondary Inorganic Constituents

Constituent	Constituent
Method 6010 (ICP/AES)	**Method 9056 (IC)**
Rubidium – Rb	
Ruthenium – Ru	
Samarium – Sm	
Tellurium – Te	
Thorium – Th	
Titanium – Ti	

IC = ion chromatography
ICP/AES = inductively coupled plasma/atomic emission spectroscopy

Note that chromium and cyanide data will be used as conservative estimates of hexavalent chromium and ferrocyanide, respectively. If the estimates are overly conservative and calculations using the estimates result in unacceptably high risk, analysis for hexavalent chromium and ferrocyanide may be performed.

4.3 ORGANIC ANALYTES

Organic chemicals will be analyzed by the following methods: GC/MS for volatile organic compounds (VOCs), extraction and GC/MS (or GC/FID) for semivolatile organic compounds (SVOCs), and GC/ECD for PCBs. In addition, a number of samples will be analyzed by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) for PCB congeners.

For VOCs and SVOCs, primary and secondary constituents are shown in Tables 4-3, 4-4, and 4-5. Analytical strategy for VOCs and SVOCs is summarized in the following.

The primary constituents will be analyzed to the quality control (QC) requirements specified in this SAP. This means they will be included in the calibration of the gas chromatographs and method detection limits (MDL) will be determined for each constituent.

Detected organic constituents that are not part of the calibration mix (primary constituents) are TICs. If a TIC is determined to be real (i.e., not an artifact of analytical methods), it will be evaluated against a gas chromatographic library containing the secondary compounds of interest. This library of compounds (called the "Hanford library") is composed of constituents that have been identified as possibly being present in Hanford Site waste in the Regulatory DQO (PNNL-12040, *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project*) but not identified as primary constituents.

The "Hanford library" was developed by running single standards of the constituents on the laboratory's GC/MS systems. The results of these analyses provide accurate retention time information and mass response factors for these compounds and permit a better evaluation of the

TIC. If a TIC is identified in the "Hanford library" of compounds, a semiquantitative estimate (based on an archived one-point calibration) of its concentration is made.

If the TIC is not found in the "Hanford library" of compounds, then the TIC will be evaluated against the standard National Institute of Standards and Technology (NIST) library of compounds. This library has over 100,000 compounds. However, because they are collected on different instruments from those used for the actual analysis, the retention times and response factors will be different. Before the analyst can name or identify the TIC, the analyst must be confident that the chromatogram and mass spectra match well enough to name the compound. If the analyst cannot confidently name the compound, it is identified as an unknown and no further action is required. When a TIC is identified in the NIST library, then the TIC will be evaluated in a similar manner as a "Hanford library" TIC.

The TICs are identified using the reconstructed ion chromatogram. The reconstructed ion chromatogram is evaluated for TICs by identifying peaks that have not already been identified as target compounds according to the following criteria. The criteria discussed in the following are from revision three of Volume 4 of DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD).

Table 4-3. Primary Volatile Organic Compound Parameters

Constituent	CAS#[a]	Comments
1,1,1-Trichloroethane	71-55-6	
1,1,2,2-Tetrachloroethene	127-18-4	
1,1,2,2-Tetrachloroethane	79-34-5	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	
1,1,2-Trichloroethane	79-00-5	
1,1,2-Trichloroethylene	79-01-6	
1,1-Dichloroethene	75-35-4	
1,2-Dichloroethane	107-06-2	
Chloroethene(vinyl chloride)	75-01-4	
2-Butanone(MEK)	78-93-3	
2-Nitropropane	79-46-9	
2-Propanone (Acetone)	67-64-1	
4-Methyl-2-pentanone (MIBK)	108-10-1	
Benzene	71-43-2	
Carbon disulfide	75-15-0	
Carbon tetrachloride	56-23-5	
Chlorobenzene	108-90-7	
Chloroform	67-66-3	
Dichloromethane (methylene chloride)	75-09-2	
Ethyl Acetate	141-78-6	
Ethylbenzene	100-41-4	

Table 4-3. Primary Volatile Organic Compound Parameters

Constituent	CAS#[a]	Comments
Diethyl ether	60-29-7	
Isobutanol	78-83-1	
Methanol	67-56-1	
n-Butyl alcohol (1-butanol)	71-36-3	
Toluene	108-88-3	
trans-1,3-dichloropropene	10061-02-6	
Trichlorofluoromethane	75-69-4	
Xylenes	1330-20-7	
o-Xylene	95-47-6	
m-Xylene	108-38-3	May be analyzed as m- and p-xylene
p-Xylene	106-42-3	May be analyzed as m- and p-xylene
~~1,1~~ Cis-1,2-dichloroethene~~benzene~~[b]	156-59-2	
~~1,2~~ Trans-1,2-dichloroethene~~benzene~~[b]	156~~9~~-60-5	

[a] CAS~~:~~ = Chemical Abstracts Service.

[b] Corrected misidentified constituents from RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study*.

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Table 4-4. Primary Semivolatile Organic Parameters ~~(2 sheets)~~

Constituent	CAS#	Comments
1,2,4-Trichlorobenzene	120-82-1	
2,4-Dinitrotoluene	121-14-2	
2,4,5-Trichlorophenol	95-95-4	
2,4,6-Trichlorophenol	88-06-2	
2,6-Bis (tert-butyl)-4-methylphenol	128-37-0	
2-Chlorophenol	95-57-8	
2-Ethoxyethanol	110-80-5	
2-Methylphenol (o-cresol)	95-48-7	
4-Methylphenol (p-cresol)	106-44-5	
Acenaphthene	83-32-9	
Butylbenzylphthalate	85-68-7	
Cresylic acid (cresol, mixed isomers)	1319-77-3	
Cyclohexanone	108-94-1	
Di-n-butylphthalate	84-74-2	
Di-n-octylphthalate	117-84-0	
N-nitroso-di-n-propylamine	621-64-7	
Ethylene glycol	107-21-1	Analyzed separately by GC/FID
Fluoranthene	206-44-0	

Table 4-4. Primary Semivolatile Organic Parameters ~~(2 sheets)~~

Constituent	CAS#	Comments
Hexachlorobutadiene	87-68-3	
Hexachloroethane	67-72-1	
m-Cresol (3-Methylphenol)	108-39-4	
Naphthalene	91-20-3	
Nitrobenzene	98-95-3	
n-Nitrosomorpholine	59-89-2	
o-Dichlorobenzene	95-50-1	
o-Nitrophenol	88-75-5	
p-Chloro-m-cresol (4-Chloro-3-methylphenol)	59-50-7	
Pyrene	129-00-0	
Pyridine	110-86-1	
Tributyl phosphate	126-73-8	
Benzo(a) anthracene	56-55-3	
Benzo(b)fluoranthene	205-99-2	
Benzo(k)fluoranthene	207-08-9	
Benzo(a)pyrene	50-32-8	
Chrysene	218-01-9	
Indeno (1,2,3-cd) pyrene	193-39-5	
Dibenz(a,h)anthracene	53-70-3	
Dibutyl phosphate	107-66-4	May be analyzed by high-performance liquid chromatography
Monobutyl phosphate	Not available	May be analyzed by high-performance liquid chromatography
Bis(2-ethylhexyl)phthalate	117-81-7	

CAS = Chemical Service Abstract

Table 4-5. Secondary Organic Constituents - "Hanford Library." (2 sheets)

Method 8260 VOC	CAS#	Method 8270 SVOC	CAS
cis-1,3-Dichloropropene	10061-01-5	p-Nitrochlorobenzene	100-00-5
Ethylene dibromide (1,2, Dibromoethane)	106-93-4	1,4-Dinitrobenzene	100-25-4
Butane	106-97-8	1,4-Dichlorobenzene	106-46-7
1,3-Butadiene	106-99-0	Phenol	108-95-2
Acrolein (propenal)	107-02-8	Hexachlorobenzene	118-74-1
3-Chloropropene (Allyl chloride)	107-05-1	N,N-Diphenylamine	122-39-4
Propionitrile (Ethyl cyanide)	107-12-0	Pentachloronaphthalene	1321-64-8
Acrylonitrile	107-13-1	Hexachloronaphtahlene*	1335-87-1
2-Pentanone	107-87-9	Tetrachloronaphthalene	1335-88-2
Methylcyclohexane	108-87-2	Octachloronaphthalene	2234-13-1
n-Pentane	109-66-0	Isodrin*	465-73-6
5-Methyl-2-hexanone	110-12-3	Benzo[a]pyrene*	50-32-8
2-Heptanone	110-43-0	Dibenz[a,h]anthracene*	53-70-3

Table 4-5. Secondary Organic Constituents - "Hanford Library." (2 sheets)

Method 8260 VOC	CAS#	Method 8270 SVOC	CAS
n-Hexane	110-54-3	1,3-Dichlorobenzene	541-73-1
Cyclohexane	110-82-7	3-Methyl-2-butanone	563-80-4
n-Octane	111-65-9	N-Nitroso-N,N-dimethylamine	62-75-9
4-Heptanone	123-19-3	Hexafluoroacetone	684-16-2
Acetic acid, n-butylester	123-86-4	Pentachloronitrobenzene (PCNB)	82-68-8
1,4-Dioxane	123-91-1	Pentachlorophenol	87-86-5
n-Heptane	142-82-5	2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	88-85-7
Cyclopentane	287-92-3	1,1'-Biphenyl	92-52-4
Ethyl alcohol	64-17-5	Acetophenone	98-86-2
2-Propyl alcohol	67-63-0	Toxaphene*	8001-35-2
n-propyl alcohol (1-propanol)	71-23-8	Nitric acid, propyl ester	627-13-4
Bromomethane	74-83-9	Aldrin*	309-00-2
Chloroethane	75-00-3	alpha-BHC*	319-84-6
Acetonitrile	75-05-8	beta-BHC*	319-85-7
1,1 Dichloroethane	75-34-3	gamma-BHC (Lindane)*	58-89-9
Dichlorofluromethane	75-43-4	Dieldrin*	60-57-1
Chlorodifluoromethane	75-45-6	Endrin*	72-20-8
3-Methy-2-butanone*	563-80-4	1,1-Dimethylhydrazine	57-14-7
Hexafluoroacetone*	684-16-2	Methylhydrazine	60-34-4
2-Butenaldehyde (2-Butenal)	4170-30-3	n-Nitrosomethylethylamine	10595-95-6
Methyl isocyanate	624-83-9	n-Nitrosodi-n-butylamine	924-16-3
n-Propionaldehyde	123-38-6		
3-Heptanone	106-35-4		
Chloromethane	74-87-3		
n-Nonane	111-84-2		
Styrene	100-42-5		
Tetrahydrofuran	109-99-9		
Cyclohexene	110-83-8		
2-Methyl-2-propenenitrile	126-98-7		
2-Hexanone	591-78-6		
Triethylamine	121-44-8		
Oxirane	75-21-8		
2-Methyl-2-propanol	75-65-0		
Dichlorodifluoromethane	75-71-8		
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2		
Heptachlor	76-44-8		

Table 4-5. Secondary Organic Constituents - "Hanford Library." (2 sheets)

Method 8260 VOC	CAS#	Method 8270 SVOC	CAS
1,2-Dichloropropane	78-87-5		
1-Methylpropyl alcohol	78-92-2		
3-Pentanone	96-22-0		

* Constituent may be analyzed by an alternate method.
~~1.3~~ CAS = Chemical Abstracts Service SVOC = Semi-volatile organic compound

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The library match for a TIC should be higher than 75% before this detailed evaluation is initiated. The method-specified tune criteria should be met. Special attention to the tune at low masses should be taken when evaluating volatile compounds. The concentration of a TIC should be greater than 10% of the nearest internal standard or estimated 5 nanograms on column injection, whichever is smaller. Early (injection peak) and late eluting peaks (column bleed and coeluting compounds) should have adequate background subtraction to permit use of these TIC criteria. If isotopic patterns are present, the mass ratios should agree with the reference spectrum within 10%. The base mass peak for the sample should be the same as the reference spectrum. If a molecular ion is present in the reference spectrum, the sample should also have a molecular ion mass. Reference spectrum ions greater than 20% should be in the sample spectrum. Sample ions greater than 20% that are not in the reference spectrum need to be evaluated. Major sample ions (greater than 20%) should match relative intensities to the base peak to those same ratios for the reference spectrum within 10-30%.

The TIC evaluation is limited to the 30 largest TICs for the volatile organic analysis and the 30 largest for the semivolatile analysis meeting the criteria discussed here.

A TIC compound may be upgraded to a positively identified compound. This is achieved by obtaining the compound, analyzing it under the same conditions as the initial identification, and matching retention time and mass spectrum. The upgrade will be performed if a TIC is a significant risk contributor.

Polychlorinated biphenyls will be analyzed by GC/ECD and HRGC/HRMS. In addition, percent water is required for solids so the PCB concentration can be reported on a dry weight basis.

Polychlorinated biphenyls Aroclors will be measured by GC/ECD. If necessary, total PCB concentrations would be calculated by summing the concentrations of seven Aroclors (1016, 1221, 1232, 1242, 1248, 1254, and 1260) found in a sample. The total PCBs in a sample are calculated by summing only detected Aroclors. If no Aroclors are detected, the total PCB concentration is considered the detection limit for the single most common Aroclor expected in the sample. Tank results indicate Aroclor 1254 is by far the most common Aroclor in Hanford Site tank waste. The policy of determining total PCB concentrations is the policy of the EPA Manchester Laboratory for determining total PCB concentrations in a sample. In addition, this method was specified by agreement in a meeting with representatives from EPA Region 10, EPA Manchester Laboratory, Ecology, Department of Energy (DOE), Pacific Northwest National Laboratory, and the Tank Operation Contract. In addition, PCB congeners will be analyzed by

HRGC/HRMS. The HRGC/RHMS results will be used to evaluate congener estimates based on GC/ECD analyses.

Monobutyl phosphate and dibutyl phosphate degrade when injected into a GC. Special preparations will be required to allow these chemicals to be analyzed by GC/MS. Alternatively, these chemicals may be analyzed by high-performance liquid chromatography.

Pesticide and petroleum analytes are shown in Table 4-6. Only samples taken in the top 15 ft will be analyzed for these organics.

Table 4-6. Pesticides and Petroleum Analytes

Constituent	Analytical Method	Alternate Method
Aldrin	Gas chromatography/electron capture detection (EPA Method 8081)	Gas chromatography/mass spectroscopy (EPA Method 8270)
Benzene hexachloride (including lindane)		
Chlordane		
DDT/DDD/DDE (total)		
Dieldrin		
Endrin		
Hexachlorobenzene		
Heptachlor/heptachlor epoxide (total)		
Pentachlorophenol		
Gasoline-range organics	Purge-and-trap gas chromatography/ mass spectroscopy (EPA Method 8260)	Gas chromatography/flame ionization detection (EPA Method 8015)
Diesel-range organics	Gas chromatography/flame ionization detection (EPA Method 8015)	Gas chromatography/mass spectroscopy (EPA Method 8270)

4.4 RADIOLOGICAL PARAMETERS

Radionuclides will be analyzed by the following methods: GEA for gamma emitters, ICP/MS for uranium and neptunium isotopes, liquid scintillation for ^{99}Tc, alpha energy analysis for plutonium, americium, and curium isotopes, liquid scintillation for ^{14}C, tritium, and ^{79}Se, separation and GEA for ^{129}I, and beta counting for ^{90}Sr. Primary constituents for these methods are shown in Table 4-7.

Table 4-7. Primary Radiological Parameters

Constituent	Analytical Method	Alternate Method
^{137}Cs	GEA	
^{60}Co	GEA	
^{152}Eu	GEA	
^{154}Eu	GEA	

Table 4-7. Primary Radiological Parameters

Constituent	Analytical Method	Alternate Method
^{155}Eu	GEA	
^{14}C	Water leach followed by liquid scintillation counting	
^{3}H	Water leach followed by liquid scintillation counting	
^{129}I	Low energy gamma counting	ICP/MS
^{63}Ni	Separation by complex formation followed by liquid scintillation counting	
^{90}Sr	Beta proportional counting	
^{99}Tc	ICP/MS	Acid leach followed by liquid scintillation counting
^{125}Sb	GEA	
^{79}Se	Precipitation/ion exchange followed by liquid scintillation counting	
^{126}Sn	ICP/MS	
^{233}U	ICP/MS	
^{234}U	ICP/MS	
^{235}U	ICP/MS	
^{236}U	ICP/MS	
^{238}U	ICP/MS	
^{237}Np	ICP/MS	Alpha counting
^{238}Pu	Alpha counting	ICP/MS
$^{239/240}Pu$	Alpha counting	ICP/MS as ^{239}Pu and ^{240}Pu
^{241}Pu	Calculate from ^{238}Pu and $^{239/240}Pu$	Extraction followed by ICP/MS
^{241}Am	Alpha counting	ICP/MS
^{242}Cm	Alpha counting	
^{243}Cm	Alpha counting	
^{244}Cm	Alpha counting	
^{228}Th	Calculation	GEA
^{230}Th	ICP/MS	
^{232}Th	ICP/MS	
^{234}Th	ICP/MS	

GEA = Gamma energy analysis
ICP/MS = Inductively coupled plasma/mass spectrometry

The only truly multiple constituent analytical method for radiochemistry is GEA. Therefore, the secondary constituents are those found in the GEA library. If a constituent in the GEA library is detected, the concentration will be reported.

Thorium-230 and ^{232}Th can be determined by alpha analysis but are normally measured by ICP/MS because of their long half-life. Thorium-228 concentration is generally determined by alpha counting or by calculation based on ^{232}Th and ^{232}U concentrations.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

Quality requirements for WMA C soil sampling and analysis are described in DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents.* Hanford onsite laboratories performing analyses in support of this SAP will have approved and implemented quality assurance (QA) plans. As required by TFC-PLN-02, *Quality Assurance Program* Description, these QA plans will meet the minimum requirements of DOE/RL-96-68 as the baseline for laboratory quality systems. If subcontracting any portion of the analytical requirements to a commercial laboratory off the Hanford site, the subcontractor's implementing quality assurance program shall comply with DOECAP, *Consolidated Audit Program Quality Systems for Analytical Services.*

All sampling and analysis activities will be performed using approved methods, procedures, and work packages that are written in accordance with approved operational and laboratory QA plans, which are consistent with the requirements of this SAP. Sampling and analysis activities shall be performed by qualified personnel using properly maintained and calibrated equipment.

5.1 QUALITY CONTROL FOR FIELD SAMPLING

Prior to sampling, sampling equipment shall be cleaned using a procedure that is consistent with SW-846 sampling equipment cleaning protocol. Only new (unused) pre-cleaned, quality-assured sample containers or containers cleaned onsite per the SW-846 protocol shall be used for sampling.

Field QC samples shall be collected to evaluate the potential for cross-contamination and laboratory performance. Soil sampling will require the collection of field duplicates, equipment rinsate blank, and trip blank samples, where appropriate. Field QC sample types and frequency for collection are described in the following subsections.

Field Duplicates

Field duplicates (i.e., samples taken at the same location) are used to evaluate precision of the sampling process. However, it is not possible to obtain direct pushes exactly at the same location. Therefore, field duplicates will not be required for direct push samples.

For surface soil samples, collocated samples will be taken. The duplicate samples shall be shipped to the laboratory in the same manner as the primary samples. They will be analyzed using the two-step approach described in Section 4.1.

Equipment Rinsate Blanks

Equipment rinsate blanks are used to verify the adequacy of sampling equipment decontamination procedures and shall be collected for each sampling method or type of equipment used. Equipment blanks shall consist of deionized water washed through decontaminated sampling equipment. Equipment rinsate blanks shall be analyzed using the two-step approach described in Section 4.1.

Trip Blanks

Trip blanks for volatile organics will be prepared at a frequency of one per day of sampling during which samples are collected for VOCs~~.constitute at least 5 % of all VOA samples~~. Trip blanks shall be prepared by adding laboratory-grade or reagent grade deionized water to a clean sample container. The trip blanks shall travel to the field with the associated bottle sets and will be returned to the laboratory with the samples. They will remain unopened during their transport and handling. Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for VOCs only.

Field Blanks

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A field blank is prepared on-site during the sample collection activities using the same reagent water source used to prepare the trip blank. Field blanks for VOCs will be prepared at a frequency of one per day of sampling during which samples are collected for VOCs. The results from this analysis are used to assess sample contamination originating predominantly from field sampling conditions.

Temperature Blanks

A temperature blank, with a water filled vial or a suitable thermometer, should be included with each cooler of samples designated for transport. Upon sample receipt, the laboratory will use the temperature blank or thermometer to determine the internal temperature of each cooler. Acceptable temperatures are 4 ±~~+~~2 °C for refrigerated aqueous and solid samples and < -7 °C to >-20 °C for frozen samples.

Prevention of Cross-Contamination

Special care should be taken to prevent cross-contamination of soil samples. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers.
- Contaminating the equipment or sample bottles by setting them on or near potential contamination sources, such as uncovered ground.
- Handling bottles or equipment with dirty hands.
- Improperly decontaminating equipment before sampling or between sampling events.

5.2 REQUIRED QUALITY CONTROL FOR ANALYSIS

As applicable, a duplicate analysis, a matrix spike, a laboratory blank, and a laboratory control sample (LCS) are required for each batch of samples. In addition, a matrix spike duplicate is required for VOA, SVOA, PCB, and Hg analyses. The matrix spike duplicate is needed due to the high number of "less than" for these analyses. Instances where these requirements are not applicable are shown in Table 5-1. Evaluation criteria for these QC analyses also are shown in Table 5-1. Where allowed by applicable SW-846 methods, statistical process control limits may be used instead of the specified criteria.

The QC criteria in Table 5-1 are goals for demonstrating reliable method performance. The laboratory's internal QA system will be used to evaluate the analytical data and processes whenever a criterion is exceeded. The laboratory may reanalyze based on the internal evaluation. Otherwise, the data will be further evaluated in accordance with the strategies described RPP-243403, *Single-Shell Tank Component Closure Data Quality Objectives*. Primary constituent data not meeting the QC requirements will be noted accordingly and discussed in the narrative of the laboratory data report.

Table 5-1. Quality Control Parameters for Constituents. (2 sheets)

		QC Acceptance Criteria		
Constituents	**Method**	**LCS % Recovery[a]**	**Spike % Recovery[b]**	**% RPD[c]**
Al, Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Sb, Se, Sr, Tl, U, V, Zn	ICP/AES	80–120%	75–125%	≤30%
Hg	CVAA	80–120%	75–125%	≤30%
F^-, NH_4^+, NO_2^-, NO_3^-, Cl^-, SO_4^{2-}, $C_2H_3O_2^-$, CHO_2^- $C_2H_3O_3^-$, $C_2O_4^{2-}$	IC	80–120%	75–125%	≤30%
CN^-	9014 (spectrophotometric)	80–120%	75–125%	≤30%
S^{2-}	9215	80–120%	75–125%	≤30%
pH	pH	± 0.1 pH Units	N/A	N/A
PCB by Aroclors	GC/ECD	70–130%	70–130%	≤30%
PCB by congeners	HRGC/HRMS	TBD	TBD	TBD
VOC	GC/MS	70–130%	70–130%	≤30%
SVOC	GC/MS (or GC/FID for ethylene glycol)	70–130%	70–130%	≤30%
Pesticides	GC/MS or GC/ECD	70–130%	70–130%	≤30%
Gasoline-range organics and diesel range organics	GC/MS or GC/FID	70–130%	70–130%	≤30%
% H_2O	Gravimetric	80–120%	N/A	≤30%
Bulk Density	Gravimetric	N/A	N/A	≤30%
^{235}U, ^{238}U, ^{237}Np, ^{232}Th, ^{126}Sn	ICP/MS	80–120%	75–125%	≤30%
^{233}U, ^{234}U, ^{236}U, ^{230}Th, ^{234}Th	ICP/MS	N/A[e]	N/A[e]	≤30%
^{228}Th	Calculation	N/A	N/A	N/A
^{60}Co, ^{137}Cs, ^{125}Sb	GEA	80–120%	N/A[f]	≤30%
^{152}Eu, ^{154}Eu, ^{155}Eu	GEA	N/A	N/A[f]	≤30%

Table 5-1. Quality Control Parameters for Constituents. (2 sheets)

Constituents	Method	QC Acceptance Criteria		
		LCS % Recovery[a]	**Spike % Recovery[b]**	**% RPD[c]**
^{129}I	GEA	80–120%	N/A[g]	≤30%
^{14}C, ^{3}H	Liquid scintillation counting	80–120%	75–125%	≤30%
^{63}Ni	Liquid scintillation counting	80–120%	N/A[g]	≤30%
^{90}Sr	Beta counting	80–120%	N/A[g]	≤30%
^{99}Tc	Liquid scintillation counting	80–120%	75–125%	≤30%
^{79}Se	Liquid scintillation counting	NP	N/A[g]	≤30%
^{238}Pu	Alpha counting	N/A[(f)]	N/A[g]	≤30%
$^{239/240}Pu$	Alpha counting	80–120%	N/A[g]	≤30%
^{241}Pu	Calculation from ^{238}Pu and $^{239/240}Pu$	N/A	N/A	N/A
^{241}Am	Alpha counting	80–120%	N/A[g]	≤30%
^{242}Cm, $^{243/244}Cm$	Calculation from ^{241}Am	N/A	N/A	N/A

CVAA = cold vapor atomic absorption
GEA = gamma energy analysis
GC/ECD = gas chromatography/electron capture detection
GC/FID = gas chromatography/flame ionization detection
GC/MS = gas chromatography/mass spectrometry
HRGC/HRMS = high-resolution gas chromatography/high-resolution mass spectroscopy
IC = ion chromatography
ICP/AES = inductively coupled plasma/atomic emission spectroscopy
ICP/MS = inductively coupled plasma/mass spectroscopy
QC = quality control
TBD = to be determined
TGA = thermogravimetric analysis
N/A = not applicable
NP = not performed

[a] LCS = Laboratory control sample. This sample is carried through the entire analytical method. The accuracy of a method is usually expressed as the percent recovery of the LCS. The LCS is a matrix with known concentration of constituents processed with each preparation and analyses batch. It is expressed as percent recovery; i.e., the amount measured, divided by the known concentration, times 100.

[b] For some methods, the sample accuracy is expressed as the percent recovery of a matrix spike sample. It is expressed as percent recovery; i.e., the amount measured, less the amount in the sample, divided by the spike added, times 100. One matrix spike is performed per analytical batch. Samples are batched with similar matrices. For other constituents, the accuracy is determined based on use of serial dilutions.

[c] RPD = Relative percent difference between the samples. Sample precision is estimated by analyzing duplicates taken separately through preparation and analysis. Acceptable sample precision is usually ≤ 30% if the sample result is at least 10 times the instrument detection limit.

RPD = [(absolute difference between primary and duplicate)/mean] x 100.

[d] reserved.

[e] No standards are run for these constituents.

[f] The measurement is a direct reading of the energy and the analysis is not affected by the sample matrix; therefore, a matrix spike is not required.

[g] Matrix spike analyses are not required for this method because a carrier or tracer is used to correct for constituent loss during sample preparation and analysis. The result generated using the carrier or tracer accounts for any inaccuracy of the method on the matrix. The reported results reflect this correction.

5.3 ANALYTICAL DETECTION LIMITS

Required detection limits as specified in the WMA C DQO are shown in Tables 5-2 and 5-3 for waste classification and ecological risk assessment, respectively. Where multiple required detection limits are specified for a single analyte, the laboratory shall meet the lower limit. Target detection limits are shown in Tables 5-4 and 5-5. Basis for the target detection limits is provided in the DQO. The laboratories are required to meet the required detection limits and shall strive to meet the target detection limits whenever possible.

~~1.~~4 **Table 5-2. Required Detection Limits for Radionuclides (2 sheets)**

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Analyte	Analytical Method	Alternate Analytical Method	Source 10 CFR 61.55 Class C Waste (pCi/g)	Biota Concentration Guide for Terrestrial Animal (pCi/g)	Required Detection Limits (pCi/g)
^{241}Am	Alpha counting	Not available	9.00E+03	3.9E+03	3.9E+02
^{14}C	Liquid scintillation counting	Not available	5.33E+06	4.8E+03	4.8E+02
^{242}Cm	Alpha counting	Not available	9.00E+03	2.1E+03	2.1E+02
^{243}Cm	Alpha counting	Not available	9.00E+03	Not available	9.00E+02
^{244}Cm	Alpha counting	Not available	9.00E+03	4.1E+03	4.1E+02
^{60}Co	GEA	Not available	Not available	6.9E+02	6.9E+01
^{137}Cs	GEA	Not available	3.07E+09	2.1E+01	2.1
^{152}Eu	GEA	Not available	Not available	1.5E+03	1.5E+02
^{154}Eu	GEA	Not available	Not available	1.3E+03	1.3E+02
^{155}Eu	GEA	Not available	Not available	1.6E+04	1.6E+03
^{3}H	Liquid scintillation counting	Not available	Not available	1.7E+05	1.7E+04
^{129}I	Low energy gamma counting	Not available	5.33E+04	5.7E+03	5.7E+02
^{63}Ni	Liquid scintillation counting	Not available	4.67E+08	Not available	4.67E+07
^{237}Np	ICP/MS	Alpha Counting	9.00E+03	3.9E+03	3.9E+02
^{238}Pu	Alpha counting	ICP/MS	9.00E+03	5.3E+03	5.3E+02
^{239}Pu	Alpha counting	ICP/MS	9.00E+03 (as $^{239/240}$Pu)	6.1E+03	6.1E+02 (as $^{239/240}$Pu)
^{240}Pu	Alpha counting	ICP/MS	9.00E+03 (as $^{239/240}$Pu)	Not available	9.00E+02 (as $^{239/240}$Pu)
^{241}Pu	Calculate from ^{238}Pu and $^{239/240}$Pu	ICP/MS	3.50E+09	Not available	3.50E+08

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~~1.4~~ Table 5-2. Required Detection Limits for Radionuclides (2 sheets)

Analyte	Analytical Method	Alternate Analytical Method	Source 10 CFR 61.55 Class C Waste (pCi/g)	Biota Concentration Guide for Terrestrial Animal (pCi/g)	Required Detection Limits (pCi/g)
^{125}Sb	GEA	Not available	Not available	3.5E+03	3.5E+02
^{79}Se	Liquid scintillation counting	Not available	Not available	Not available	Not available
^{90}Sr	Beta proportional counting	Not available	4.67E+09	2.3E+01	2.3
^{99}Tc	Liquid scintillation counting	ICP/MS	2.00E+06	4.5E+03	4.5E+02
^{126}Sn	ICP/MS	Not available	Not available	Not available	Not available
^{228}Th	Calculation	GEA	Not available	5.3E+02	5.3E+01
^{230}Th	ICP/MS	Not available	Not available	1.0E+04	1.0E+03
^{232}Th	ICP/MS	Not available	Not available	1.5E+03	1.5E+02
^{233}U	ICP/MS	Not available	9.00E+03	4.8E+03	4.8E+02
^{234}U	ICP/MS	Not available	9.00E+03	5.1E+03	5.1E+02
^{235}U	ICP/MS	Not available	9.00E+03	2.8E+03	2.8E+02
^{236}U	ICP/MS	Not available	Not available	Not available	Not available
^{238}U	ICP/MS	Not available	9.00E+03	1.6E+03	1.6E+02

GEA = gamma energy analysis ICP/MS = inductively coupled plasma/mass spectroscopy

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Table 5-3. Required Detection Limits for Non-Radionuclides[1] (3 sheets)

Analyte	Soil Concentration for Protection of Terrestrial (mg/kg)			SST Priority [2]	Required Detection Limit(mg/kg)
	Plants	Soil Biota	Wildlife		
METALS:					
Aluminum (soluble salts)	50			Primary	5
Antimony	5			Primary	0.5
Arsenic III[3]			7	Primary	0.7
Arsenic V[3]	10	60	132	Primary	1
Barium	500		102	Primary	10.2
Beryllium	10			Primary	1
Boron	0.5			Secondary	6
Bromine[4]	10			Primary	1
Cadmium	4	20	14	Primary	0.4

Table 5-3. Required Detection Limits for Non-Radionuclides[1] (3 sheets)

Analyte	Soil Concentration for Protection of Terrestrial (mg/kg)			SST Priority [2]	Required Detection Limit(mg/kg)
	Plants	Soil Biota	Wildlife		
Chromium (total)	42	42	67	Primary	0.15[10]
Cobalt	20			Primary	2
Copper	100	50	217	Primary	5
Fluorine[5]	200			Primary	20
Iodine[6]	4				
Lead	50	500	118	Primary	5
Lithium	35			Secondary	3.5
Manganese	1,100		1,500	Primary	110
Mercury, inorganic	0.3	0.1	5.5	Primary	0.01
Molybdenum	2		7	Secondary	4
Nickel	30	200	980	Primary	3
Selenium	1	70	0.3	Primary	0.03
Silver	2			Primary	0.2
Technetium[6]	0.2				
Thallium	1			Primary	0.1
Tin	50			Secondary	6
Uranium	5			Primary	0.5
Vanadium	2			Primary	0.2
Zinc	86	200	360	Primary	8.6
PESTICIDES:[7]					
Aldrin			0.1	Secondary	0.01
Benzene hexachloride (including lindane)			6	Primary	0.6
Chlordane		1	2.7		0.1
DDT/DDD/DDE (total)			0.75		0.075
Dieldrin			0.07	Secondary	0.007
Endrin			0.2	Secondary	0.02
Hexachlorobenzene			17		1.7
Heptachlor/heptachlor epoxide (total)			0.4		0.04
Pentachlorophenol	3	6	4.5	Secondary	0.3
OTHER CHLORINATED ORGANICS:					
1,2,4-Trichlorobenzene		20		Primary	2
1,2-Dichloropropane		700		Secondary	
1,4-Dichlorobenzene		20		Secondary	
2,4,5-Trichlorophenol	4	9		Primary	0.4

Table 5-3. Required Detection Limits for Non-Radionuclides[1] (3 sheets)

Analyte	Soil Concentration for Protection of Terrestrial (mg/kg)			SST Priority [2]	Required Detection Limit(mg/kg)
	Plants	Soil Biota	Wildlife		
2,4,6-Trichlorophenol		10		Primary	1
Chlorobenzene		40		Primary	4
PCB mixtures (total)[8]	40		0.65	Primary	0.065
OTHER NONCHLORINATED ORGANICS:					
Acenaphthene	20			Primary	2
Benzo(a)pyrene			12	Secondary	1.2
Di-n-butyl phthalate	200			Primary	20
OTHER NONCHLORINATED ORGANICS: cont'd					
Nitrobenzene		40		Primary	4
Phenol	70	30		Secondary	
Styrene	300			Secondary	
Toluene	200			Primary	20
PETROLEUM[9]:					
Gasoline Range Organics		100	5,000 except that the concentration shall not exceed residual saturation at the soil surface		10
Diesel Range Organics		200	6,000 except that the concentration shall not exceed residual saturation at the soil surface		20

[1] Blank cells indicate that no value is available.
[2] Only Primary and Secondary contaminants from the SST DQO (RPP-23403, Rev. 3) are included in this table except for pesticides where all pesticides listed WAC 173-340-900 Table 749-3 are included. For primary analytes, if detected a numerical value is reported, if not detected, analyte is reported with a less than minimum detection limit (MDL). For secondary organic analytes, if detected a numerical value is reported as an estimate, if not detected, the analyte is not reported. This is the same process used in SST DQO RPP-23403, Rev. 3.
[3] Total arsenic is reported (same as SST DQO (RPP-23403, Rev. 3)
[4] Bromine is reported as bromide (same as SST DQO (RPP-23403, Rev. 3, where it was classed as secondary)
[5] Fluorine is reported as fluoride (same as SST DQO (RPP-23403, Rev. 3, where it was classed as primary)
[6] Included in the radionuclide analysis, radionuclide will be converted from radioactivity to mass using specific activity. Iodine-129 and Technetium-99 were both classed as primary in SST DQO (RPP-23403, Rev. 3)
[7] In addition to the SVOA analysis, EPA Method 8081 for pesticides will also be performed to meet the reporting requirements for ecological indicator soil concentrations.
[8] PCBs reported as individual Arochlors and total PCB
[9] Petroleum contaminants are not included in the SST DQO but will be measured in soil for ecological risk assessment.
[10] This required detection limit is based on a maximized sample size. If a maximized sample size cannot be collected, the detection limit will be higher than indicated.

Table 5-4. Target Detection Limits for Primary Radionuclides

CAS# or Constituent Identifier	Analyte	Survey or Analytical Method	Target Detection Limits (pCi/g)
14234-35-6	Antimony-125	Gamma GS	0.3
14596-10-2	Americium-241	^{241}Am alpha energy analysis	1
14762-75-5	Carbon-14	C-14 LSC (low level)	1
10045-97-3	Cesium-137	Gamma GS	0.1
10198-40-0	Cobalt-60	Gamma GS	0.05
15510-73-3	Curium-242	^{241}Am/^{244}Cu alpha energy analysis	1.0
15757-87-6	Curium-243	^{241}Am/^{244}Cu alpha energy analysis	1.0
13981-15-2	Curium-244	^{241}Am/^{244}Cu alpha energy analysis	1.0
14683-23-9	Europium-152	Gamma GS	0.1
15585-10-1	Europium-154	Gamma GS	0.1
14391-16-3	Europium-155	Gamma GS	0.1
15046-84-1	Iodine 129	^{129}I LSC	2
13994-20-2	Neptunium-237	ICP/MS	1
13981-37-8	Nickel-63	^{63}Ni LSC	30
13981-16-3	Plutonium-238	Alpha energy analysis	1
Pu-239/240	Plutonium-239/240	Alpha energy analysis	1
13982-63-3	Radium-226	Gamma GS	0.2
15758-85-9	Selenium-79	^{79}Se LSC	10
Rad-Sr	Strontium-90	^{89,90} Sr total Sr - gas proportional counting	1
14133-76-7	Technetium-99	Liquid scintillation counting	1
14274-82-9	Thorium-228	TBD	1
14269-63-7	Thorium-230	ICP/MS	1
Th-232	Thorium-232		1
10028-17-8	Tritium	Tritium – H-3 LSC(mid level)	30
13966-29-5	Uranium-233/234	ICP/MS	1
15117-96-1	Uranium-235		1
U-238	Uranium-238		1

CAS = Chemical Abstracts Service
GS = gamma spectroscopy.
LSC = liquid scintillation counter.
ICP/MS = inductively coupled plasma/mass spectrometry
TBD = to be determined

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
7429-90-5	Aluminum	EPA Method 6010	5
7440-36-0	Antimony	EPA Methods 6010, 6020, or 200.8 (trace)	0.6
7440-38-2	Arsenic	EPA Methods 6010, 6020, or 200.8	1
7440-39-3	Barium	EPA Methods 6010, 6020, or 200.8	20
7440-41-7	Beryllium	EPA Methods 6010, 6020, or 200.8	0.5
7440-43-9	Cadmium	EPA Methods 6010, 6020, or 200.8	0.5
7440-47-3	Chromium (III)/chromium (total)	EPA Methods 6010, 6020, or 200.8	1
7440-48-4	Cobalt	EPA Methods 6010, 6020, or 200.8	2
7440-50-8	Copper	EPA Methods 6010, 6020, or 200.8	1
7439-89-6	Iron	EPA Methods 6010, 6020, or 200.8	5
7439-92-1	Lead	EPA Methods 6010, 6020, or 200.8	5
7439-96-5	Manganese	EPA Methods 6010, 6020, or 200.8	1.9
7439-97-6	Mercury	EPA Methods 7470, 7471, 6020, or 200.8	0.2
7439-98-7	Molybdenum	EPA Methods 7470, 7471, 6020, or 200.8	19
7440-02-0	Nickel	EPA Methods 6010, 6020, or 200.8	4
7782-49-2	Selenium	EPA Methods 6010, 6020, or 200.8	1
7440-22-4	Silver	EPA Methods 6010, 6020, or 200.8	2
7440-24-6	Strontium	EPA Methods 6010, 6020, or 200.8	1
7440-28-0	Thallium	EPA Methods 6010, 6020, or 200.8	0.5
7440-61-1	Uranium	EPA Methods 200.8, 6020, or kinetic phosphorescence absorption	1
7440-62-2	Vanadium	EPA Methods 6010, 6020, or 200.8	2.5
7440-66-6	Zinc	EPA Methods 6010, 6020, or 200.8	1
57-12-5	Cyanide (includes ferrocyanide)	EPA Methods 9010C total cyanide or 335	0.5
16984-48-8	Fluoride	IC, EPA Method 9056 or 300.0	5
14797-55-8	Nitrate	IC, EPA Method 9056 or 300.0	2.5
14797-65-0	Nitrite	IC, EPA Method 9056 or 300.0	2.5
16887-00-6	Chloride	IC, EPA Method 9056 or 300.0	0.3
14808-79-8	Sulfate	IC, EPA Method 9056 or 300.0	2.7
71-50-1	Acetate	IC, EPA Method 9056 or 300.0	4.5
64-18-6	Formate	IC, EPA Method 9056 or 300.0	10.0

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
79-14-1	Glycolate	IC, EPA Method 9056 or 300.0	3.8
144-62-7	Oxalate	IC, EPA Method 9056 or 300.0	2
18496-25-8	Sulfide	EPA Method 9030	5
NA	Ammonium (NH_4)	EPA Method 300.7	0.5
67-64-1	Acetone	EPA Method 8260	0.02
71-43-2	Benzene	EPA Method 8260	0.0015
75-15-0	Carbon disulfide	EPA Method 8260	0.005
56-23-5	Carbon tetrachloride	EPA Method 8260	0.0015
108-90-7	Chlorobenzene	EPA Method 8260	0.005
67-66-3	Chloroform (trichloromethane)	EPA Method 8260	0.005
108-94-1	Cyclohexanone	EPA Method 8270	0.5
107-06-2	1,2-Dichloroethane	EPA Method 8260	0.0015
75-35-4	1,1-Dichloroethylene	EPA Method 8260	0.01
75-09-2	Dichloromethane (methylene chloride)	EPA Method 8260	0.002
10061-02-6	Dichloropropene; 1,3,- (trans-)	EPA Method 8260	0.005
141-78-6	Ethyl acetate	EPA Method 8015	5
60-29-7	Diethyl ether	EPA Method 8015, 8260	5
100-41-4	Ethyl benzene	EPA Method 8260	0.005
67-72-1	Hexachloroethane	EPA Method 8270	0.33
108-10-1	Methyl isobutyl ketone (MIBK hexone)	EPA Method 8260	0.01
78-93-3	Methyl ethyl ketone (MEK)	EPA Method 8260	0.01
79-46-9	Nitropropane; 2-	EPA Method 8260	0.002
79-34-5	Tetrachloroethane; 1,1,2,2-	EPA Method 8260	0.005
127-18-4	Tetrachloroethene (PCE)	EPA Method 8260	0.005
108-88-3	Toluene	EPA Method 8260	0.005
76-13-1	trichloro-1,2,2-trifluoroethane; 1,1,2-	EPA Method 8260	0.010
71-55-6	1,1,1-Trichloroethane (TCA)	EPA Method 8260	0.005
79-00-5	1,1,2-Trichloroethane	EPA Method 8260	0.002
107-21-1	Ethylene glycol	EPA Method 8015	5

Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
156-59-2	Cis-1,2,-dichlorobenzene	EPA Method 8260	0.0003
156-60-5	Trans-1,2-dichlorobenzene	EPA Method 8260	0.0004
83-32-9	Acenaphthene	EPA Method 8270	0.33
117-81-7	Bis(2-ethylhexyl)phthalate	EPA Method 8270	2.95
71-36-3	Butanol; n- (n-butyl alcohol)	EPA Method 8260, 8015	5
85-68-7	Butylbenzylphthalate	EPA Method 8270	0.33
95-57-8	Chlorophenol; 2-	EPA Method 8270	0.33
M + P CRESOL	Cresol; m + p (3/4-Methylphenol)	EPA Method 8270	0.33
95-48-7	Cresol; o- (2-Methylphenol)	EPA Method 8270	0.33
1319-77-3	Cresylic acid (cresol, mixed isomers)	EPA Method 8270	0.5
84-74-2	Dibutylphthalate (Di-n-butylphthalate)	EPA Method 8270	0.33
117-84-0	Di-n-octylphthalate	EPA Method 8270	0.33
95-50-1	Dichlorobenzene; 1,2-(ortho-)	EPA Method 8270	0.33
121-14-2	Dinitrotoluene; 2,4-	EPA Method 8270	0.33
110-80-5	Ethoxyethanol; 2-	TBD	TBD
206-44-0	Fluoranthene	EPA Method 8270	0.33
87-68-3	Hexachlorobutadiene	EPA Method 8270	0.33
78-83-1	Isobutyl alcohol (Isobutanol)	EPA Methods 8260 or 8015	5
128-37-0	methylphenol; 2,6-Bis(tert-butyl)-4-	EPA Method 8270	1.2
59-50-7	methylphenol; 4-Chloro-3-(p-Chloro-m-cresol)	EPA Method 8270	0.33
91-20-3	Naphthalene	EPA Method 8270	0.33
98-95-3	Nitrobenzene	EPA Method 8270	0.33
88-75-5	Nitrophenol; o-	EPA Method 8270	0.66
621-64-7	Nitroso-di-n-propylamine	EPA Method 8270	0.33
79-01-6	Trichloroethylene (TCE)	EPA Method 8260	3.7E-4
75-69-4	Trichlorofluoromethane	EPA Method 8260	0.01
~~1.5~~ ~~75-014 41~~75-01-4	Vinyl chloride	EPA Method 8260	0.01
1330-20-7	Xylenes	EPA Method 8260	0.01

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Table 5-5. Target Detection Limits for Primary Chemicals (4 sheets)

CAS# or Constituent Identifier.	Analyte	Survey or Analytical Method	Target Detection Limits (mg/kg)
108-38-3	Xylene; m-	EPA Method 8260	5.1E-4
95-47-6	Xylene; o-	EPA Method 8260	2.4E-4
106-42-3	Xylene; p-	EPA Method 8260	5.1E-4
120-82-1	1,2,4 - Trichlorobenzene	EPA Method 8270	0.33
59-89-2	Nitrosomorpholine; N-	EPA Method 8270	0.33
129-00-0	Pyrene	EPA Method 8270	0.33
110-86-1	Pyridine	EPA Method 8270	0.66
95-95-4	Trichlorophenol; 2,4,5-	EPA Method 8270	0.33
88-06-2	Trichlorophenol; 2,4,6-	EPA Method 8270	0.33
		EPA Method 8041	0.165
126-73-8	Tributyl phosphate	EPA Method 8270	3.3
107-66-4	Dibutyl phosphate	EPA Method 8270	TBD
--	Monobutyl phosphate	EPA Method 8270	TBD
56-55-3	Benzo (a) anthracene	EPA Method 8270	0.33
205-99-2	Benzo (b) fluorathene	EPA Method 8270	0.33
207-08-9	Benzo (k) fluorathene	EPA Method 8270	0.33
50-32-8	Benzo (a) pyrene	EPA Method 8270	0.33
218-01-9	Chrysene	EPA Method 8270	0.33
53-70-3	Dibenzo (ab) anthracene	EPA Method 8270	0.33
193-39-5	Indeno (123-cd) pyrene	EPA Method 8270	0.33
2674-11-2	Aroclor 1016	PCBs, EPA Method 8082	0.02
11104-26-2	Aroclor 1221	PCBs, EPA Method 8082	0.02
11141-16-5	Aroclor 1232	PCBs, EPA Method 8082	0.02
53969-21-9	Aroclor 1242	PCBs, EPA Method 8082	0.02
126572-29-6	Aroclor 1248	PCBs, EPA Method 8082	0.02
11097-6999-1	Aroclor 1254	PCBs, EPA Method 8082	0.02
11096-82-5	Aroclor 1260	PCBs, EPA Method 8082	0.02
Not available	PCB congeners	PCBs, EPA Method 1668	TBD

CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency.
IC = ion chromatography.
N/A = not applicable.
PCB = polychlorinated biphenyl.
TBD = to be determined

6.0 DATA REPORTING

If soil sample analysis is performed at the 222-S Laboratory, the data report(s) will be in Format VI. A description of a Format VI report is provided below. Additional details of a Format VI report can be found in ATL-MP-1011, *Quality Assurance Project Plan for 222-S Laboratory*.

Format VI Report with QA Verification—:

- Narrative – contains a description of sample receipt, sample breakdown, and ha~~ve~~s a section corresponding to each method describing any analytical/QC deviations from the work plan.
- Results Table (Data Summary Report) – printout containing sample and duplicate results, relative percent difference, standard and spike recoveries, blank results, and data qualifiers (flags).
- Sample section that contains sample breakdown diagrams, chains of custody, and geologist's descriptions.
- Section that contains all e-mail correspondence documenting issues that arose during sampling and analysis, and subsequent decisions that affected initial work instructions.
- Laboratory will perform a QA review of the data package. Typical QA reviews require a minimum 10% review.

~~Format V – Legally Defensible Data Package – Resource Conservation Recovery Act (RCRA) Data Package: This data package is sometimes referred to as a "Stand-Alone Data Package" and is intended to support projects and sampling activities where the data are used to meet regulatory compliance areas and could be subject to litigation. The data package includes all data from samples and associated field QC samples. It is organized into a narrative section that includes a summary table of the analytical data and a data report section that includes applicable raw sample data. A Format V report includes all data that are needed for a successfully data validation. Data needed for validation will be included and will represent a minimum of 5% of all collected samples. Specifically, the following data are included with sample data to support data validation:~~

- ~~Laboratory control sample/standard concentrations and all raw data (including laboratory notebook pages) needed to check the calculation of the percent recovery~~
- ~~All raw data needed to check the calculation of the reported blanks~~
- ~~All raw data needed to check the RPDs and percent recoveries reported~~

- ~~ICP and inductively coupled plasma/mass spectrometer (ICP/MS) sensitivity and linear ranges~~
- ~~Metal interference check sample results~~
- ~~Initial and continuing calibration verification raw data~~
- ~~Instrument tuning data and instrument run logs~~
- ~~Column performance check (organic analyses) with standard including the chromatogram~~
- ~~Chromatograms (for organic analyses)~~

  ~~Sample Identification~~

  ~~Method Identification~~

  ~~Retention time of compound(s) identified~~

- ~~Quantitative chromatogram report~~

  ~~Analyte retention time~~

  ~~Amount of sample injected~~

  ~~Results of response factors~~

  ~~Surrogate recovery results~~

  ~~Concentration of compound found~~

  ~~Date and time of injection~~

- ~~Calibration Data~~

  ~~Calibration curve or empirical equation for the curve~~

  ~~Correlation coefficient of the linear calibration~~

  ~~Concentration and/or response factor data for calibration check standards including dates of analysis~~

  ~~GC/MS daily tuning results~~

  ~~Calibration data should be submitted by the chemist to the data packaging group as requested.~~

The data package will also include TICs found in VOA and SVOA. A discussion of the TIC evaluation process shall be provided in the narrative. A Format VI data package is subject to internal laboratory QA verification and review including peer review prior to release.

If sample analysis is performed at other laboratories, format for the data reports will be equivalent to a 222-S Laboratory Format VI report.

In addition to the data package(s), an electronic version of the analytical results shall be provided to the ~~Hanford Environmental Information System (~~HEIS~~)~~ database.

7.0 CHANGE CONTROL

Field activity and laboratory work scope changes may be required because of unexpected field conditions, new information, health and safety concerns, or other circumstances. Changes to work scope may result in modifications to this SAP. Work scope changes that do not result in deviation from the SAP requirements, can be made in the field or laboratory with the approval of the project manager or assigned task lead. These work scope changes will be documented in the sampling work package and/or Format VI laboratory report(s). Justification for the changes to work scope shall be provided in sufficient detail to understand the basis for the change. Alternately, if field or laboratory conditions result in substantial work scope changes, the SAP may be revised with DOE and Ecology approval.

Field sampling and survey methods and analytical strategies (e.g., constituent listings and data analysis) may be updated as new technologies or data become available. The impact of these updates to the SAP will be judged as they are identified to determine if revisions to the SAP will be necessary. Ecology, DOE, and its contractors will participate in the SAP update evaluation process and any subsequent revisions to the SAP.

8.0 REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

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WAC-173-340-820, "Sampling and Analysis Plans," *Washington Administrative Codes*, as amended.

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APPENDIX A

QUALITY ASSURANCE PROJECT PLAN FOR PHASE 2 CHARACTERIZATION OF VADOSE ZONE SOIL IN WASTE MANAGEMENT AREA C

QUALITY ASSURANCE PROJECT PLAN FOR PHASE 2 CHARACTERIZATION OF VADOSE ZONE SOIL IN WASTE MANAGEMENT AREA C

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- ~~U.S. Department of Energy (DOE) Order 414.1C, *Quality Assurance*~~ASME NQA-1,~~-~~ *2004~~,~~ Quality Assurance Requirements for Nuclear Facility Applications (QA)*,
-
- ~~10 CFR 830.120, "Quality Assurance Requirements"~~DOE/RL-96-68, ~~2008,~~ *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)~~, Rev. 3, U.S. Dept of Energy, Richland Operations Office, Richland, Washington~~
-
- EPA/240/B-01/003~~EPA QA/R-5~~, *EPA Requirements for Quality Assurance Project Plans*, *EPA QA/R-5*,
- TFC-PLN-02, "Quality Assurance Program Description" (QAPD)

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A-1.0 PROJECT MANAGEMENT

This section addresses the basic areas of project management, and it ensures that the project has a defined goal, that the participants understand the goal and approach to be used, and that the planned outputs have been appropriately documented. The QAPjP is organized according to the elements described in EPA/240/B-01/003~~-QA/R-5~~.

A-1.1 PROJECT/TASK ORGANIZATION

The project organization is described in the subsections that follow and is shown in Figure A-1.

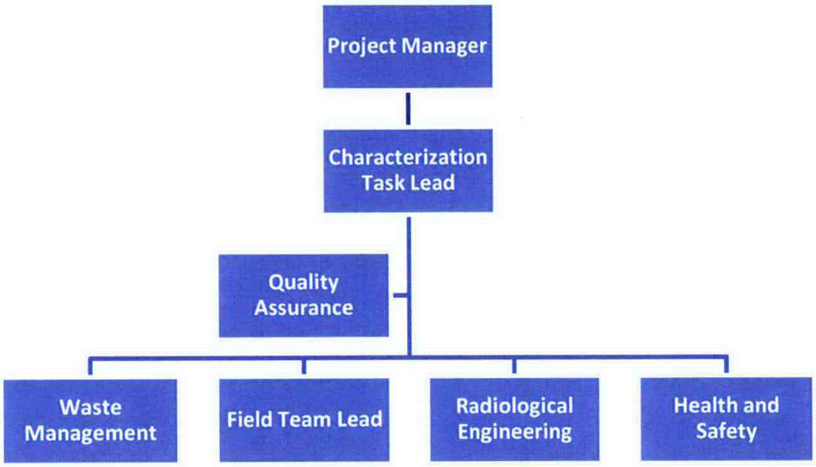
Project Manager

The Project Manager provides oversight for all activities and coordinates with DOE and Ecology in support of sampling activities. In addition, support is provided to the task lead to ensure that the work is performed safely and cost-effectively.

Characterization Task Lead

The Characterization Task Lead is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The task lead ensures that the field team lead, samplers, and others responsible for implementation of this SAP and the QAPjP are provided with current copies of this document and any revisions thereto. The task lead works closely with quality assurance, health and safety, and the field team leader to integrate these and the other lead disciplines in planning and implementing the work scope. The task lead also coordinates with and reports to DOE, Ecology, and the Tank Operation Contractor on all sampling activities.

Figure A-1. Project Organization



The task lead is responsible for selecting the laboratories that perform the analyses and requests assessments/surveillances of the laboratories. The task lead receives the analytical data from the laboratories, and arranges for data entry into the Hanford Environmental Information System (HEIS) database. The task lead is also responsible for a review of sample data against existing knowledge and data quality assessments according to guidelines in EPA/600/R-96/084 ~~QA/G-9~~, *Guidance for Data Quality Assessment*, *Practical Methods for Data Analysis, EPA QA/G-9, QA00 Update*.

Quality Assurance

Quality Assurance is responsible for quality assurance issues on the project. Responsibilities include oversight of implementation of the project quality assurance requirements; review of project documents, including SAPs (and the QAPjP); and participation in quality assurance assessments and surveillances on sample collection and analysis activities, as appropriate.

Waste Management

The Waste Management lead communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Other responsibilities include identifying waste management sampling/characterization requirements to ensure regulatory compliance interpretation (e.g., with WAC 173-303, "Dangerous Waste Regulations") of the characterization data to generate waste designations, profiles, and other documents that confirm compliance with waste disposal requirements.

Field Team Leader

The field team leader has the overall responsibility for the planning, coordination, and execution of the field sampling activities. Specific responsibilities include converting the sampling design requirements into field work plans or task instructions that provide specific direction for field activities. Responsibilities also include directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The field team leader communicates with the Characterization Task Lead to identify field constraints that could affect the sampling design. In addition, the field team leader directs the procurement and installation of materials and equipment needed to support the field work.

The field team leader oversees field-sampling activities that include sample collection, packaging, provision of certified clean sampling bottles/containers, documentation of sampling activities in controlled logbooks, chain-of-custody documentation, and packaging and transportation of samples to the laboratory or shipping center.

Radiological Engineering

The Radiological Engineering lead is responsible for radiological engineering and health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, radiological hazards are identified and appropriate controls are implemented to maintain worker exposures to the hazards at levels as low as reasonably achievable. Radiological Engineering interfaces with the project safety and health representative and plans and directs radiological control technician support for all activities.

Health and Safety

Responsibilities include coordination of industrial safety and health support within the project as carried out through safety and health plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by internal Tank Operation Contractor work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personnel protective clothing requirements are coordinated with Radiological Engineering.

A-1.2 PROBLEM DEFINITION/BACKGROUND

See Sections 1.0 and 2.0 of the SAP.

A-1.3 PROJECT/TASK DESCRIPTION

See Sections 3.0 and 4.0 of the SAP.

A-1.4 QUALITY OBJECTIVES AND CRITERIA

See Sections 4.0 and 5.0 of the SAP.

A-1.5 SPECIAL TRAINING/CERTIFICATION

Sampling and laboratory personnel shall complete the necessary training and must receive appropriate certification to perform assigned tasks in support of the characterization project. The environmental safety and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically will have completed the following training before starting work:

- Occupational Safety and Health Administration 40-hour hazardous waste worker training and supervised 24-hour hazardous waste site experience
- 8-hour hazardous waste worker refresher training (as required)
- Hanford general employee radiation training
- Radiological worker training.

A graded approach is used to ensure that workers receive a level of training commensurate with their responsibilities that complies with applicable U.S. Department of Energy orders and government regulations. Specialized employee training includes prejob briefings, on-the-job training, emergency preparedness, plan-of-the-day activities, and facility/worksite orientations.

A-1.6 DOCUMENTS AND RECORDS

All information pertinent to field sampling and surveying will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols. The sampling team will be responsible for recording all relevant sampling information. Entries made in the logbook will be dated and signed by the individual who made the entry. Program requirements for managing the generation, identification, transfer, protection, storage, retention, retrieval, and disposition of records within the Tank Farms Contractor will be followed.

Requirements for laboratory data reporting are discussed in Sections 6.0 and 7.0 of the SAP.

A-2.0 DATA GENERATION AND ACQUISITION

A-2.1 SAMPLING PROCESS DESIGN

See Section 3.0 of the SAP.

A-2.2 SAMPLING METHODS

See Section 3.0 of the SAP.

A-2.3 SAMPLE HANDLING AND CUSTODY

See Section 3.0 of the SAP.

A-2.4 ANALYTICAL METHODS

See Table 5-1 of the SAP.

A-2.5 QUALITY CONTROL

Quality control sample requirements and acceptance criteria for these samples are specified in Section 5.0 of the SAP. Overall quality assurance and quality control requirements for characterization are discussed in this section.

A-2.5.1 Quality Assurance Objective

The quality assurance objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed by representativeness, comparability, accuracy, and precision. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. Each of these is addressed in the following subsections.

Representativeness

Representativeness is a measure of how closely the results reflect the actual concentration and distribution of the chemical and radiological constituents in the matrix sampled. Sampling design has been developed and sampling techniques have been selected with the goal of optimizing representativeness of the samples.

Comparability

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained using standard procedures and consistent methods and units.

Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. A matrix spike is the addition to a sample of a known amount of a standard compound similar to the compounds being measured. Sample accuracy is expressed as the percent recovery of a spiked sample. Table 5-1 provides the accuracy criteria for laboratory analyses.

Precision

Precision is a measure of the data reproducibility when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference for duplicate measurements or relative standard deviation for triplicates. Table 5.1 lists the analytical precision criteria for fixed laboratory analyses.

Detection Limits

Detection limits are functions of the analytical method used to provide the data and the quantity of the sample available for analyses. Required and target detection limits for the COPCs are presented on Tables 5-2 through 5-5.

Laboratory Quality Control

The laboratory method blanks, duplicates, laboratory control sample/blank spike, and matrix spikes are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* and will be run at the frequency specified in Chapter 1 of SW-846. In the event sample material is not sufficient to perform all analyses, sample quantity will be prioritized and allocated to completion of the method analysis. If insufficient sample is available for completion of laboratory QC analyses, the laboratory will be make note of the condition in the data package narrative and the associated data results will have laboratory qualifies added as appropriate.

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A-2.5.~~3~~2 Sample Preservation, Containers, and Holding Times

Sample preservation, containers, and holding times for radiological and nonradiological analytes are shown in Table A-1.

Table A-1. Sample Preservation, Container, and Holding Time Guidelines

Analytes	Matrices	Bottle		Preservation	Packing Requirements	Holding Time
		Type	Lid			
Radionuclides	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	None	6 months
IC anions	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	Cool 4 °C	48 hours
ICP metals	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	None	6 months
Mercury	Soil/Sludge/ Sediment/Scale	G	Teflon®-lined cap	None	None	28 days
Total cyanide	Soil/Sludge/ Sediment/Scale	G	Teflon®-lined cap	None	Cool 4 °C	14 days
pH (soil)	Soil/Sludge/ Sediment/Scale	G/P	Teflon®-lined cap	None	None	As soon as possible after receiving sample
SVOA, pesticides, and diesel-range organics	Soil/Sludge/ Sediment/Scale	AG	Teflon®-lined cap	None	Cool 4 °C	14/40 days
VOA and gasoline range organics	Soil/Sludge/ Sediment/Scale	AG	Teflon®-septum cap	Sodium bisulfate	Cool 4 °C	14 days
PCBs	Soil/Sludge/ Sediment/Scale	G	Teflon®-lined cap	None	Cool 4 °C	None

AG = amber glass
CVAA = cold vapor atomic absorption
EPA = U.S. Environmental Protection Agency
G = glass
GC = gas chromatography
IC = ion chromatography
ICP = inductively coupled plasma
P = plastic
PCB = polychlorinated biphenyl
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

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A-2.5.~~4~~3 Sample Collection Requirements

See Section 3.0.

A-2.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment per manufacturer or other applicable guidelines. Maintenance requirements (such as parts lists and documentation of routine maintenance) will be included in the individual laboratory and the onsite organization quality assurance plan or operating procedures (as appropriate). Calibration of laboratory instruments will be performed in a manner consistent with SW-846~~, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*~~ as implemented by~~or~~ DOE/RL-96-68~~, *Hanford Analytical Services Quality Assurance Requirements Documents*~~.

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Note that contamination is monitored by the QC samples discussed in Section 5.0 of the SAP.

A-2.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

See Sections 5.2 and A-2.6.

A-2.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

See Section A-2.6.

A-2.9 NON-DIRECT MEASUREMENTS

See Section 3.0 for a discussion of field survey techniques.

A-2.10 DATA MANAGEMENT

See Section 6.0 for data reporting requirements.

A-3.0 ASSESSMENT AND OVERSIGHT

A-3.1 ASSESSMENT AND RESPONSE ACTIONS

Project management and Quality Assurance may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. Deficiencies identified by these assessments shall be reported in accordance with existing programmatic requirements. Corrective actions will be implemented as required by the Tank Operation Contractor policy and procedures.

A-3.2 REPORTS TO MANAGEMENT

Management will be made aware of deficiencies identified by assessments and surveillances and subsequent corrective actions.

A-4.0 DATA VALIDATION AND USABILITY

A-4.1 DATA REVIEW, VERIFICATION, AND VALIDATION

Sample analysis data will be reviewed by laboratory QA and chemists prior to issuance. The characterization task lead will be responsible for checking completeness of the data report(s), reviewing results against any existing knowledge, and assessing the data to determine if they are adequate for the intended use. Third-party data validation is not required for SST tank waste sample results (see RPP-23403~~,~~ *Single-Shell Tank Component Closure Data Quality Objectives*). Both tank waste and soil sample data will be used for WMA C closure. ~~Therefore, data validation also is not required for WMA C soil sample results.~~Third-party data validation will be performed on at least 5% of WMA C soil sample results.

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A-4.2 VERIFICATION AND VALIDATION METHOD

See above section (Section A-4.1).

A-4.3 RECONCILIATION WITH USER REQUIREMENTS

The data quality assessment process compares completed field-sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. Data quality assessment will be performed according to guidelines in EPA/600/R-96/084~~, *Guidance for Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9 QA00 Update*~~.

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A-5.0 QUALITY ASSURANCE PROJECT PLAN REFERENCES

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